APRIL 1, 1918

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VOLUME IV
Number 5

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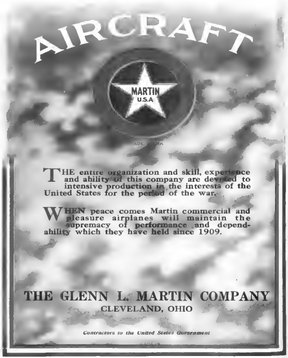
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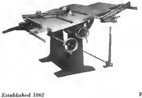

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APRIL 1, 1918

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VOL. IV. NO. 5

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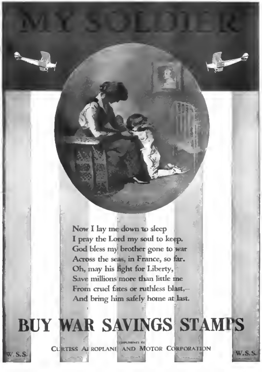


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Vol. IV April 1, 1918 No. 5

# Organized Airplane Spruce Production

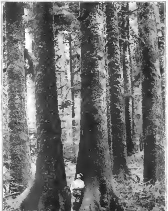
By J. Frederic Thorne
*Portland Chamber of Commerce*

Few people outside of army circles, and only a small number within, appreciate the immensity and importance of the undertaking signified by what is officially designated as "The Spruce Production Division of the Signal Corps of the United States Army." This is because it is new not only in its formation and activity but also in its conception and scope. Yet the organization and its work is the largest business venture of any kind ever attempted by the West.

The problem facing this business—and it is very strictly a business run along business lines—includes not only the military features incident to its army organization, but also industrial, manufacturing and transportation problems, each of which is a huge industry in itself and yet must be worked out to the smallest detail. It is a creation; nor has there been any precedent upon which to lay down even preliminary plans.

When Colonel Brice P. Disque, U. S. A., who is in command, took charge he was faced with chaos from which to evolve order. Here was a colossal logging operation with the spruce stands scattered over a coast line of two thousand miles and these stands representing only a small percentage of the timber in which they were located.

Here was an unprecedented condition of selection, operation and transportation, all to be put through at a speed never before required or thought of. The spruce production of the Northwest was in the hands of numerous companies and operators, small and large, working without the slightest relation to each other, in competition, and on a more or less hit and miss plan according to their individual needs or interests. The idea of pooling their efforts or coöperating in activities practically was unthought of.


TYPICAL STAND OF SPRUCE IN OREGON
*Photo Gifford and Prentiss*

In addition to the commercial and physical difficulties Colonel Disque found the smoldering fires of a labor war, embers that constantly were blazing into flame here and there in the form of strikes, lockouts, shutdowns, bitter recriminations on both sides, sabotage and all forms of labor troubles that were incited and actively supported in all possible ways by a vicious pro-Hun element.

*Colonel Disque's Problems*

Colonel Disque had to fight the enemy without by producing spruce upon an enormous scale, and the enemy within by weeding out the enemy element that, for the moment, was placing a very serious handicap upon lumber production and threatening absolute paralysis of the entire industry. Coincidentally there was an insistent demand, amounting almost to a wail of distress, by the government for spruce, more spruce, and yet more spruce for the construction of airplanes.

The Spruce Production Division, while nominally a part of the Signal Corps, is in a way and in its operation an individual unit of itself formed for the one specific and definite purpose of producing the spruce demanded by the needs of the United States Government and its Allies.

There are now between ten and twelve thousand officers and men of the Army assigned to this division and attached to Vancouver Barracks, with the main administrative offices in Portland, Ore. The officers are, as a rule, men with previous timber or lumbering experience detailed from the various training schools and camps as well as from the regular army personnel. The enlisted men volunteered or were drafted from Oregon, Washington, Idaho, Montana, Michigan, Wisconsin, Maine and the timber states of the South-

east. With very few exceptions they were practical lumbermen before their induction into the army, and those few exceptions were men picked for their special qualifications for the particular work they are doing. It is a division of experts. Any labor deficiency that arises or may occur is being supplied by details of soldiers in both camps and mills.

At the time of the formal opening of the Government spruce cut up plant at Vancouver Barracks, Feb. 7, Colonel Disque in addressing five thousand men of the Spruce Division troops, said in part

"As a matter of history, I am going to tell you briefly what the spruce situation was in October. The production at that time was a little over two million feet a month, about one-fifth of what we required. Every logger, or practically all of them, was doing all he could to produce it, and the mills were sawing all they could obtain, as they were accustomed to sawing all kinds of lumber. To expand logging operations in the forests of Oregon and Washington even gradually is a large task, but to expand them to a point where they would meet the requirements of our government and its allies seemed an impossible task. The railway equipment, tracks and roads were not in existence, and it would have taken years to have obtained the required spruce by normal means.

"The only way out of it that I could see was to go into the forests and select the spruce and get it without the use of extensive railway equipment. That is what we started to do. We decided to rive or split selected trees and, having reduced the size of the pieces, it was a much simpler matter to transport it to the railway—furthermore the split timber had to run with the straight grain and that is just what we are after.

"We are now assured of a supply sufficient to keep ahead of our requirements. It is now past the experimental stage and the large increase in production has proven beyond question that it is the only way to supplement the normal industry's output. This does not mean that we do not want every foot that the ordinary operators can produce and all the mills can cut. All they can bring in we want, we have contracts for it and we will continue to buy and receive it."

### *Labor Troubles Discounted*

He showed how critical labor conditions in the lumber camps when he took charge last Fall have been adjusted, better hours and working conditions obtained for the men, and their loyal cooperation obtained.

He showed how enough spruce has been contracted for and opened up for operation through the building of eighty-seven miles of railroad and construction of truck roads to supply present needs of the government and its future needs for eighteen months to come.

He showed how the overhead cost of spruce production has been reduced from $5 to $15 per thousand feet, the commission formerly paid Eastern brokers, to $1.34 per thousand feet.

He showed how production has been increased until in February twice as much spruce stock was shipped East as in November, and four times as much as in the month he took charge.

He showed how the production of desirable airplane stock was increased 11 per cent in February over January figures, through the work of a technical department, which is also improving the specifications.

He showed how the time it takes to move spruce from Oregon and Washington to the Atlantic Coast has been reduced, through the work of a traffic department, from fifty days to ten days.

He showed how the operation of the new cut-up plant for spruce at Vancouver, Wash., has already effected a saving of 75 per cent in the number of freight cars required to move the spruce East, a total of about 3000 cars a year.

### *Equipment Difficulties Removed*

He showed how the Loyal Legion had been organized with 65,000 patriotic workers in both the spruce and fir production fields.

He showed how 10,000 volunteers for the work had been organized among the drafted men to help in spruce production as needed, and how 2000 of these men, all expert logging men, had been put in the camps since February 4, working the same hours and for the same pay as the civilian loggers and under such circumstances that labor had not been antagonized.

### *Gigantic Problem Presented*

One big difficulty in the way of increasing production 500 per cent, Colonel Disque explained, lay in the fact that of some 5,000,000,000 ft. of spruce timber in Oregon and Washington, not more than 200,000,000 ft. will meet the rigid requirements of straight grain airplane spruce.

"If we took the 5,000,000,000 ft. and brought it in here," said he, "we couldn't get rid of it. It would swamp us. So we decided that the only sensible, intelligent thing to do was to go into the woods, select the trees meeting the requirements for airplane spruce, split them up then and there and take the pieces out."

In order not to interfere with operations of big crews, closer in, Colonel Disque said, it was necessary to go into the more remote districts, to build a few miles of railroad and some track roads to bring out rived spruce after the trees had been selected and rived.

He declared that the mills of Oregon and Washington were not equipped to cut spruce to meet airplane requirements, and demonstrated how rigid the specifications must be by showing them pieces of sawed spruce that appeared to meet requirements, but had split because not cut properly. Therefore, he explained, it had been necessary to build the cut-up plant at Vancouver and to bring the rived spruce there.

"One result from this cut up plant already has been a tremendous saving in the number of freight cars required," he emphasized. "When we came here, it took about 2000 ft. of specification 1 spruce to make one airplane. Now it takes only 400 ft., which saves 75 per cent in the number of cars required to ship it East, or 3000 cars a year."

Colonel Disque told how in taking "the extreme measures" he had ruthlessly cut away a lot of red tape, had taken steps that encroached on the law, and had smashed all kinds of Army precedents. But it had to be done.

The labor situation when he took charge was described as being "very critical." Today the workmen are satisfied and are working under better hours and conditions. He told of the organization of the Loyal Legion, and what a success it has been.

### *Labor Unrest at End*

"Our attempt has been to stabilize the labor situation," he said. "And today we are sending out all the spruce they can use, and more."

In answer to a question, Colonel Disque said that Oregon and Washington are furnishing virtually all the spruce for the airplanes of both the United States and its Allies, a very small proportion of the output coming from British Columbia, New England and the South. All these sources of supply put together were negligible, he said. He explained that the Allies take 60 per cent of the Northwest's output, and the United States 40 per cent.

Details of the arrangement made in establishing the basic eight hour day, carrying with it prescribed working conditions and wage scales, were announced in a bulletin issued by Colonel Disque. More than 62,000 employes in the woods and mills, members of the Loyal Legion of Loggers and Lumbermen, are affected by the officially promulgated order, applicable to the War Department's program for maximum production of lumber in Western Oregon and Washington to win the war. With the issuing of the bulletin announcement was made that the government's bonus for rived spruce has been extended to June 30. The bulletin follows:

### *Official Bulletin*

1.—The undersigned having been authorized by unanimous vote of the representatives of a convention of the logging camp and lumber mill operators and also by a convention of delegates representing 62,000 members of the Loyal Legion of Loggers and Lumbermen, to determine what will be conducive to a maximum production of material necessary for our war program both in airplane stock and ship material and to that end to determine certain questions regarding labor conditions in the logging and lumber industry of the states of Oregon and Washington west of the Cascade mountains, the following decisions are published and strict compliance of operators and employes is enjoined.

2.—It is decided that the entire industry, logging camps and lumber mills, adopt the basic eight hour day principle as of March 1, 1918, with the understanding that time and a half be paid for overtime when men are worked more than eight hours, except as hereinafter provided.

3.—It is further decided that all employes shall work actually on the job a full eight hours each of six days per week and that no camp or mill shall work a crew more than eight hours, producing its product, nor more than six days per week. This does not prohibit working two or three shifts per day of eight hours each.

4.—The following schedule represents as near as can be determined the average of all wages in the industry. It must be realized that conditions of operation, location, etc., have for years made it necessary that there be a variation in this schedule for different camps.

| | | | |
|---|---|---|---|
| Blacksmith | Optional | High climber, per hour | .80 |
| Blacksmith's helper, per hour | $.40 | Hooker man, per hour | .55 |
| Brakeman, head, per hr. | .60 | Hook tender, per hour | .90 |
| *Brakeman, second, per hour | .55 | *Knotters, per hour | .45 |
| Barker, per hour | .55 | Loader, head, long log, per hour | .75 |
| Barker, head, per hour | .55 | Loader, head, short log, per hour | .65 |
| Barker, windfall, per hour | .55 | Loader, second, long and short, per hour | .55 |
| Barker, wood, per hour | .65 | Log R. R. Men (construction), per hour | .40 |
| *Camp helper, per month | 90.00 | | |
| Chaser, per hour | .65 | | |
| Chokerman, per hour | .55 | Machinist | Optional |
| *Cook | Optional | Main line section men, per hour | .55 |
| *Cook, second, per month | 100.00 | *Pump man, per hour | .45 |
| Drum tender, per hour | .45 | Rigger, head, per hour | .65 |
| *Engineer, donkey, per hour | .60 | Rigger, second, per hour | .55 |
| *Engineer, Duplex, per hour | .50 | Rigger, third or helper, per hour | .55 |
| *Engineer, locomotive | Optional | Rigging slinger, per hour | .55 |
| Faller, head, per hour | .60 | C. O. rigging man, per hour | .55 |
| Faller, second, per hour | .55 | Signal boy, per hour | .40 |
| Filer, head, per hour | .65 | Skidroad man, per hour | .45 |
| Filer, second, per hour | .60 | Sniper, per hour | .50 |
| *Fireman, donkey, per hr. | .45 | Spool tender, per hour | .47 |
| *Fireman, locomotive, per hour | .40 | *Superintendent | Optional |
| *Foreman, grade | .45 | Swamper, per hour | .45 |
| *Foreman, section, per hour | .45 | Unhook man, per hour | .55 |
| *Foreman, track, per hr. | .45 | *Waiter and dishwasher, per month | 95.00 |
| *Head handy man, per hour | .65 | Wood splitter, per hour | .45 |
| | | *Woods foreman | Optional |

5.—In order that employes may meet the conditions peculiar to their own camps they are authorized to increase the hourly wage in the case of any employe up to but not exceeding 10 cents per hour over the above schedule. This must not be understood as approving of a general horizontal increase because certain men and certain jobs will always be worth more than others.

### *No Wage Reduction*

6.—There will be found a few exceptional cases where men have been receiving daily wages higher than authorized by this bulletin. Many operators have recommended it, such men as were employed, actually or in suspension, on February 25, may continue to receive such higher pay upon approval of this office of lists to be submitted at once by employers of such men—it being the fundamental idea of this office that no man shall have his old 10-hour daily wages reduced as a result of the adoption of the basic eight-hour day.

7.—Men marked by an asterisk (*) must be considered as daily employes who are not entitled to extra pay for work in excess of eight hours, which is ordinarily and customarily performed to insure continued operation of the plant. Their pay contemplates such service, and no extra pay will be allowed.

8.—Men when engaged in necessary repairs, moving, construction, fighting fires or other emergency, working beyond the eight hour day or on Sundays, as well as railroad crews when operating trains in connection with such service, will receive straight time for such extra work.

9.—The following maximum pay of certain employes in sawmills should be considered as the greatest to be paid and in no way as a standard.

| | | | |
|---|---|---|---|
| Car loader (equivalent rate per M) per hour | $.50 | Laborer, per hour | .45 |
| Carriage man, per hour | .47½ | Log deck, per hour | .52½ |
| *Cook | Optional | Millwright, per hour | .67½ |
| *Assistant cook, per month | 100.00 | Assistant millwright, per hour | .57½ |
| | | Offbearer, per hour | .55 |
| Dogger, per hour | .50 | Oilers, per hour | .52½ |
| Edgerman | Optional | Filer (or equivalent rate per M) per hour | .55 |
| Assistant edgerman, per hour | .50 | Planer feeder, per hour | .52½ |
| *Engineer, chief | Optional | Planer trimmer, per hour | .50 |
| *Engineer, helper | Optional | Resawyer, per hour | .60 |
| Filer, head | Optional | Setter, per hour | .55 |
| Filer, circular | Optional | Tallyman | Optional |
| Filer, assistant circular | Optional | Trimmerman | Optional |
| *Fireman, head, per hour | .47 | Assistant trimmerman, per hour | .50 |
| *Fireman, assistant, per hour | .45 | *Waiter and dishwasher, per month | 85.00 |
| *Foreman, all | Optional | | |
| Grader, per hour | .55 | | |

10.—Probably no mill pays all their employes the amounts stated, but certain men in certain mills under their special conditions earn the scale as written and it is therefore established as a maximum scale for the designations stated. It must not be expected that this maximum will be paid in all mills or in all positions.

11.—There will be found a few exceptional cases where men have been receiving daily wages higher than authorized by this bulletin. Many operators having recommended it, such men as were employed, actually or in suspension, on February 28, may continue to receive such higher pay upon approval of this office of lists to be submitted at once by employers of such men, it being the fundamental idea of this office that no man shall have his old ten hour daily wages reduced as a result of the adoption of the basic eight hour day.

12.—Men marked by the asterisk (*) must be considered as daily employes who are not entitled to extra pay for work in excess of eight hours, which is ordinarily and customarily performed to insure continued operation of the plant. Their pay contemplates such service and no extra pay will be allowed. Also it must be understood that men operating machines must tune them up before or after the eight hour day and such work is not overtime.

13.—Men engaged in making repairs and construction work, teamsters, chauffeurs, transportation men, loaders, graders and tallymen

LOADING SPRUCE ON WAY TO THE CUT-UP PLANT
*Photo Gifford and Prentiss*

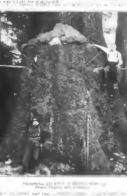
when required for work necessary to the continued eight hour production of the product, shall receive straight time for such period worked in excess of eight hours.

*No Overtime Work*

14. It is not the intention of this office to authorize any overtime work in general operation, and if production must be increased, additional crews or shifts must be established.

15.—No employer will furnish [illegible] transportation to or from place of employment for an employe. [illegible]

16.—Certified copies of the schedule in each camp and mill will be filed with this office [illegible]



SKIRTING [illegible]
*Photo [illegible]*

[illegible] and that [illegible] a exception [illegible] food and preparation [illegible] of kitchen and dining [illegible]

18.—It is further decided [illegible] first [illegible] accommodations for their men [illegible] highest [illegible] supply clean bedding including [illegible] pillows [illegible] sheets and pillow slips [illegible] all men [illegible] that a charge [illegible] per week be made for the service [illegible] per day [illegible] of the first four days of [illegible] week. The service shall include change of sheets and pillow slips weekly or oftener. Where the majority of the employes of any company agree this provision may be dispensed with.

19.—Men employed in camps or mills at work which does not come within the designations printed above will be paid such pay as is mutually agreed upon between employer and employe.

20.—It is recommended that wages be paid to employes every two weeks.

21.—This corrected bulletin is made necessary because of natural development of the problem. Every point has been carefully and conscientiously considered. Possibly other changes of minor importance may be necessary. It must be kept constantly in mind that this office is the neck of the funnel for all ideas, facts, information and conditions and that every decision will be made after mature consideration.

22.—It is requested that employers and employes co-operate to the limit in eliminating all technicalities and petty contentions. Trivial questions must be overlooked and serious ones submitted to this office for relief. This office expects an reduction in production and a spirit of "pull together" to justify the action already taken.

23.—The life of your nation and the safety of the world is largely dependent upon the future performances of the men interested in this bulletin and reduction of production by wilful neglect on the part of either employer or employe in any camp or mill in the lumber industry in the Pacific Northwest is no less treason than would be a strike or disobedience of orders among soldiers or sailors. Just claims of employers and employes will arise, but a fair and just means of solving them has been found and a square deal is guaranteed. In the future no one will be allowed to block the lumber requirements of our country.

*Loyal Legion Organized*

The pro-Hun propaganda and activities have been met and offset by Colonel Disque through the formation early last December of an organization known as the Loyal Legion of Loggers and Lumbermen, which is, in reality, an industrial army and adjunct to the Spruce Division. This Legion now numbers over 62,000 members, employes and employers, in the spruce and fir camps of the Pacific Northwest getting out lumber for the needs of the nation. The organization is bound together solely by a fervid spirit of patriotism that has been found fully sufficient as an indissoluble bond. There are no dues, nor, in the ordinary sense, any compulsory restrictions or by-laws. The men are loyal Americans banded together for the prosecution of one of the most important industries of the war program, men who need no oath or other compulsion to do their utmost of patriotic endeavor. Individually and collectively they realize that they are performing a service fully as important and worthy of as much honor as the men in the front line trenches.

Almost immediately upon the formation of the Legion both the open and hidden enemies suffered complete defeat; sabotage and slacking four attacks disappeared except for an occasional individual attempt to blow the cold embers of sedition into life again. When these sporadic attempts occur they are met with full and swift suppression.

It is Colonel Disque who says how long the men shall work and how much they shall be paid, what the living conditions of the camp shall be, what the employers must provide and what the workers shall supply. There will be no more labor troubles in the lumber camps of the Pacific Northwest where the Loyal Legion is in operation.

In one instance the men threatened an instant strike because two men refused to join the Legion and trouble was averted only by the discharge of the two employes.

*The Government's Demands*

The government now is demanding for airplane production 11,000,000 ft. of spruce per month. It must be remembered that this is not the gross cut but represents only about 15 per cent of the log, the airplane specifications calling for only the highest and best part of the logs. Great as is this demand, it is said that the Northwest section easily can meet it for the next three years without any difficulty and, if necessary, probably could duplicate the supply.

The commandeer order of the government which gives the Spruce Production Division of the United States Signal Corps authority to take spruce suitable for airplanes wherever located and by whoever owned adds interest to a survey of available spruce in Oregon and Washington which has just been made by the United States forest service as follows:

"An inventory of the Sitka spruce stumpage of Washington and Oregon, recently made by the forest service, indicates that there are about 11 billion feet of this timber within the spruce belt of these two states. This inventory was undertaken under the direction of District Forester Cecil for the use of the Spruce Production Division of the Signal Corps, that there might be available positive data as to the annual and distribution of all the possible airplane material."

*Data of Public Record*

The data were secured largely from county records, but have been supplemented by many private cruises which were patriotically furnished by the timberland owners for this purpose. The records so obtained have been presented on cards—a single card for each section—upon which the estimated stand on each 40, the name of the owner, timber quality, etc., are entered. In this card index from this large mass of detailed information is convenient for use.

The summary of this detailed data shows the following amounts of spruce for each of the counties in the spruce belt:

WASHINGTON

| | Ft. B.M. | |
|---|---|---|
| Clallam county | 2 187 000 000 | |
| Jefferson county | 2 182 000 000 | |
| Grays Harbor county | 775 000 000 | |
| Pacific county | 959 000 000 | |
| Wahkiakum county | 161 000 000 | |
| Whatcom, Skagit, Snohomish, King, Pearce and Mason counties | 311 000 000 | |
| | | 6 575 000 000 |

OREGON

| | Ft. B.M. | |
|---|---|---|
| Clatsop county | 1 257 800 000 | |
| Tillamook county | 936 500 000 | |
| Lincoln county | 900 000 000 | |
| Lane county | 190 000 000 | |
| Douglas county | 582 000 000 | |
| Coos county | 468 000 000 | |
| | | 4 374 300 000 |
| Total for Washington and Oregon | | 10 949 300 000 |



The majority of this spruce is held in private ownership. In Oregon the amount of government stumpage is very small and the amount that is accessible is negligible. In Washington there is about 600,000,000 ft. on the Quinault Indian reservation (in Grays Harbor county), and 950,000,000 ft. on the Olympic national forest (about equally divided between Clallam, Jefferson and Grays Harbor counties). Of this only a very little is now near enough to transportation to be a factor in the spruce production campaign.

*Alaska Timber Averages Lower*

In Alaska there are between 15,000,000,000 and 18,000,000,000 ft. of Sitka spruce, but less than a billion feet of this is thought to be of a quality to yield airplane stock.

Because of the absence of county cruises or for other reasons the estimates for Tillamook and Douglas counties are not complete, but are based on private cruises for part of the territory only. They include however all the main bodies of spruce, or those which are known to be of good quality. There is some additional spruce not included in the table, which occurs in scattered stands or is of too poor quality to be worth considering for airplane purposes.

The estimate for Lane and Lincoln counties had to be based on general knowledge of the forests of the region in the absence of many detailed cruises.

The 11,000,000,000 ft. in Washington and Oregon have been classified as a matter of interest, as follows:

Four billion feet are reasonably accessible at the present time or could be made accessible by short extensions of existing transportation routes.

Two and one-half billion feet are in large bodies, so inaccessible at present that extensive construction would be necessary to reach it.

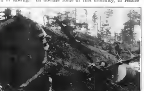
Three and one-half billion feet are either in scattered inaccessible stands, or consist of rough, low grade timber.

*Small Part Airplane Stock*

Though the gross amount of stumpage looks large, it must be remembered that not every tree will produce airplane lumber and the best of them but a small percentage. The entire 4,000,000,000 ft. that are considered reasonably accessible, therefore, could, under the most efficient manufacture, be expected to yield only two or three hundred million feet of acceptable airplane lumber.

Port Orford cedar is now being used in airplane construction, and Oregon is the source of supply for this timber. The available supply is limited to Coos and Curry counties. In the former county the inventory of the privately owned timber shows 250,000,000 ft.; in Curry county there is probably as much more; and in the Siskiyou national forest, in government ownership, another 250,000,000 ft. of cedar.

The requirement that the spruce used for airplane be cut with and not across the grain, not only reduces the proportion of a log that can be used, but also calls for the highest skill in sawing. To obviate some of this difficulty, to reduce



"BUCKING" SPRUCE FOR AIRPLANES
*Photo Gifford and Prentiss*

wastage and to lessen the necessary transportation from the woods to the mills, rived or split spruce is being used to a considerable degree, since this allows of sorting and grading in the woods. The selection of clear, straight grained trees is, of course, most important, requiring good judgment and careful consideration. After the timber is felled and bucked to the desired lengths, logs are jacked out and the splitting started at the small end of the log. Seven or eight pound steel wedges are used, lined perpendicular down through the center of the log and placed about eight inches apart. After the steel wedges have cracked the log the entire distance across the end, wooden wedges are driven for the completion of the operation.

# The Model C.V Albatros Biplane

Among the enemy airplanes which have been recently been captured on the Western front by the Royal Flying Corps and are now on exhibition in London, a two-seater fighter, the Model C.V Albatros biplane, elicits considerable attention.

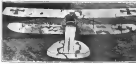


FIG. 1. REAR VIEW FROM ABOVE OF THE ALBATROS C.V

This machine, which is here described and illustrated after *Flight*, proves of particular interest as a specimen of modern German airplane construction, because it tends to show that some, and not the least well known, enemy airplane designers are displaying a growing sympathy toward the use of veneer in body construction.

The German C-series airplanes are generally termed "all purpose" machines, because they are used for reconnaissance, fire control, fighting and tactical bombing. This tendency to use a machine for various functions is distinctly German, being at considerable variance from the French leaning at specialization.

Aerodynamically, the Albatros to be dealt with in what follows is, perhaps, chiefly interesting on account of the evident attempt on the part of the designer to provide as good a stream-line body as is possible, having regard to such external fitments as machine guns, etc., which naturally detract, to a certain extent, from the efficiency of the lines of a body of a modern two-seater, where the gunner frequently has to stand up, with the upper portion of his body projecting above the body covering. This effort at stream-lining is particularly noticeable in the nose of the machine, where the aluminum cowling over the engine is carried right across, leaving only the exhaust collector exposed. In front of the covering of the body proper is a cowl shaped as a truncated cone, which serves to enclose the nose and reduction gear of the engine, and to carry the lines of the body into those of the "spinner" around the boss of the air screw. The sides of the body, from a short distance behind this cowl to the tail, are flat, as is also the bottom, but the top of the fuselage is covered with a curved covering of three-ply.

At the rear the body terminates in a horizontal knife edge, an easy flow being provided for the air by running the top covering of the body into the three-ply covering of the fin in a smooth curve. Similarly, the fixed tail plane, which is of a symmetrical section and very deep, has its top surface practically in continuation of the top covering of the body, pre-

seeing no great and abrupt changes in curvature. The total effect is one of the extremely smooth and easy-flowing curves, and the body resistance cannot be very great in proportion to the cross sectional area of the body. We have no figure of the actual resistance coefficient in the formula $R = kAV^2$, but are inclined to imagine that the coefficient $k$ has quite a low value.

As regards the rest of the machine, the Albatros designer does not appear to have been so careful in cutting down resistance. For instance, the wings have the usual circular section stranded cables for taking lift and landing stresses, and no attempt appears to have been made at stream lining these.

Constructionally, the Albatros shows much that is of interest, chiefly in the construction of the body, but also in other respects. Fundamentally, the Albatros body construction is that employed in building light boats and hydroplanes. There is a light framework, consisting of four main rails at the corners of the rectangular section body, two auxiliary rails somewhere about halfway up on the sides, and bulkheads or transverse partitions of varying shape and thickness along the body at intervals. The whole is then, as in boat building, covered with a skin of ply-wood, in this case three ply. Regarded as a compromise, this form of body construction would appear to be quite good. Without entailing the time and expense of the true monocoque body, it provides a reasonably good stream-line form. As a manufacturing proposition, it is probably about equal to the girder type of body, while it has the advantage of not requiring any truing up in the erecting process, this following automatically when making the parts over jigs and formers. One advantage this form of body does appear to possess, although to a somewhat lesser extent than the true monocoque—shall splinters and rifle and machine-gun bullets are less likely to damage it seriously than is the case with the girder type. In the latter, should a longeron be shot through, nearly all the strength of the structure is gone, whereas this semi-monocoque structure would retain its strength even after damaging some of the longitudinal members.

Finally, there is the question of strength for weight. We have no data relating to tests of such a structure carried out by our authorities, although possibly such tests may have been, and certainly should be, made. But in its issue of April 4, 1914, *Flight* published particulars of an Albatros biplane which was brought over to England and flown there by Thelen, which had a body fundamentally similar to the one at present under discussion, although differing from it in minor details. At the time details were furnished of tests carried out on an Albatros body of this type by the Deutsche Versuchsanstalt für Luftfahrt, according to which the factor of safety of the Albatros body was about 60, and the resistance to bending 2.5 times greater than that of a diagonally wired body of the same outside dimensions, and having members of the size usually employed in structures of this type. The Versuchsanstalt also stated that the Albatros firm were justified in concluding that the bending resistance of the veneer type of body is greater than that of a cross-wired body of the same weight, although no actual figures were given showing how much greater.

When looking into the detail construction of the Albatros body, the first thing that impresses one, apart from the absence of internal cross bracing, is the extensive use that has been made of ply-wood in the construction of the transverse bulkheads or formers, which take the place of the struts and cross members of the girder type of body. In Fig 5 are shown the different bulkheads of the body, with dimensions, etc. The rail, halfway up the sides of the body, is placed parallel with the propeller shaft, thus serving as a datum line from which to make measurements of distances and angles.

In order to enable our readers to better form a conception of the Albatros construction, we have shown, in Fig 5, half-sections of the more important and representative bulkheads. In the front portion of the body the bulkheads, which here have to take the weight of the engine, are about 1¼ in. thick, and are made up of a number of laminations of wood, which are, of course, so placed in relation to one another that the grains of adjacent layers run at angles to one another. It was further noticed that in making up these bulkheads whole sheets of the different woods were not always employed. On the contrary, many of the layers appear to have been shouldered or spliced, being made up of comparatively small pieces. It is possible that this has been done with a view to utilising pieces of wood that would otherwise have had to be scrapped.

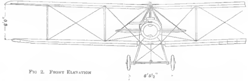



Fig 2. Front Elevation

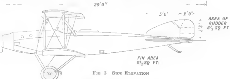



Fig 3 Side Elevation



On the other hand, it may have been done to increase the amount of crossing of the different grains. In any case, it would appear to serve both purposes, although one would expect the time taken in manufacture to be somewhat increased by such careful fitting together of small pieces of wood.

Fig 7 shows the nose of the Albatros, and clearly indicates the method of supporting the engine. The first bulkhead, it will be seen, is solid, and is at right angles to the propeller shaft. The second bulkhead (No 2, Fig 5) is lightened by piercing, as shown, and is also vertical, while the third engine support is formed by a solid bulkhead (No 3, Fig 5), which slopes back so as to support the front chassis struts and front cabane struts at its lower and upper ends respectively. As the front engine support is clearly shewn in the sketch, Fig. 7, it has not been included in Fig. 5. The bulkhead (No. 1, Fig. 5) is merely a former, and does not help to support the engine bearers. These are of I section spruce, and have plywood flanges applied on top and bottom. The upper flange is continued outwards to the middle longeron so as to form a shelf or bracket at the sides of the engine.

A construction somewhat different from that of the engine supports is employed in the panel between the pilot's and gunner's cockpit. This consists (No. 4, Fig 5) of a spruce framework faced each side with 3 mm three-ply, the whole having a thickness of 26 mm (about 1 in.). Behind the gunner's cockpit is a light partition built up as shown in 5, Fig 5. Two

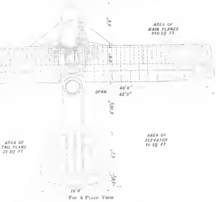



Fig 4 Plain View

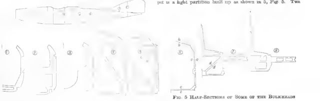


Fig. 5 Half-Sections of Some of the Bulkheads

light spruce struts run diagonally from corner to corner of the body, crossing in the center of the fuselage, at which point they are reinforced by three-ply facings and triangular blocks glued onto the corners.

Their attachment to the upper and lower body longerons is of a similar construction and will be clear from the diagram. On their front faces these diagonal struts are provided with a 2 mm flange to stiffen them against buckling. A canvas

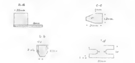


Fig 6 Dimensions of Sections of Fig. 5

curtain is secured to the front of the partition, having in it pockets for maps, etc.

From this point back to the point where the tail plane and vertical fin are attached, the formers of the body are in the nature of a very light framework of thin struts, a typical one being shown in 6, Fig 5. The general construction and some of the dimensions of the various members will be clear from the illustration.

One of the features in which the present Albatros differs from previous types is the construction and attachment of the tail plane and vertical fin. The latter is covered with three-ply, and is made integral with the body, out of which it grows, so to speak. The construction is shown in Nos 7 and 8, Fig 5, and in the perspective sketch, Fig 8. The tail skid is supported on one and sprung from the other of these two bulkheads, as illustrated in Fig 9, the general and detail construction of it being evident from the sketches. The tail plane

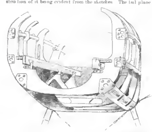


Fig 7 Forward Portion of the Body Showing Engine Bearers

is provided with hollow spars, which fit over cantilever beams integral with bulkheads, Nos 7 and 8, Fig 5, the details of which arrangement will be dealt with later.

### The Body Longerons

The body longerons are of a somewhat complicated nature, varying as they do along their entire length, not only as regards being tapered from front to rear, but also in the different form of spindling out employed at the various points, and in the method of reinforcing with other strips of wood, partly in order to increase their strength where required and partly to make their overall section conform to the various angles and curvatures of the outside three ply covering of the body.

From Fig 10 a fairly good idea may be formed of the shape and dimensions of the longerons at various points. The lower

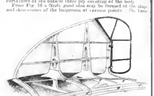


Fig 8 Construction of the Vertical Fin

one (left hand) is originally of rectangular section but is lightened from point to point by various forms of spindling and step-chamfering. Thus at the point B (see key, diagram Fig 10) the inner face of the bottom longeron is spindled out on its inner face with a curved cutter. At other points of the longeron, farther toward the stern, various sections are met with, as channel, solid rectangle, and L sections of various proportions. Between the horizontal stern post and the point at which the middle longeron meets the lower one, the latter is reinforced with a triangular section strip, so as to carry the three ply covering onto the sloping side. Similarly at the section A, Fig 10, the longeron, which is here of solid rectangular section, is reinforced on the outer side with a curved strip, spindled out externally, and with a smaller strip on the lower face of the longeron, which at this point is subjected to an increased compressive load, owing to the overhanging engine. It also serves to afford attachment for the three-ply covering

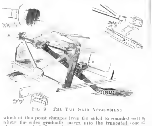


Fig 9 The Tail Skid Attachment

which at this point changes from the solid to rounded section, where the sides gradually merge into the truncated cone of aluminum, which forms the extreme nose of the body proper, i e, at the point just behind the "spinner" on the air screw boss.

The upper longeron, which is originally of rectangular section, is spindled out to channel and L sections at various points, as shown in X, Y, Z, Fig 10. So as to form an attachment for the curved top of the body, the top longerons have glued to their upper face additional strips of triangular section, while at the point Y, Fig 10, the section is left rectangular, so as to form a support for the gun ring. In addition to their function as strengthening members, these strips serve the farther purpose of preventing the bulkheads from sliding



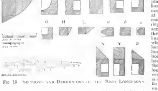


Fig 10 Sections and Dimensions of the Body Longerons

along the longerons, as they are cut off where a bulkhead occurs, against the front and rear sides of which they abut. In some places, as, for instance, in the front of the body, where the covering is in form of an aluminum cowl over the engine, the strips are omitted and the cowl attached to turn buttons, as shown in Fig 12. At such points the bulkheads are prevented from sliding along the longerons by a long wood screw passing horizontally through the longeron into the bulkhead.

The middle longerons, which, as already pointed out previously, are horizontal, i e, parallel to the propeller shaft, are of smaller overall dimensions than are the four main longerons. They are of rectangular section, lightened in places by step-chamfering, as shown in a and b, Fig 10

Fig 11 shows, in side elevation and plan, the general arrangement of the body, and should, in conjunction with the various sections and key diagrams, explain fairly clearly the general lay-out of the body. It will be noticed that in plan the sides of the body are straight from the tail post forward to the pilot's cockpit. For ease in manufacture, it is an advantage that the ribs of the tail plane should be at right angles to the spars, and in order to effect this it is necessary that the sides of the body should be parallel for the length of the tail plane. Since, however, to provide for this the longerons would have to be changed from a converging direction to a parallel one, which would necessitate a somewhat sharp bend in them at the point where the tail plane commences, and, as moreover, the depth of the tail plane is not the same as that of the body, except at the extreme rear, a different course has been followed. From the point where the tail begins, two extra longerons on each side have been built into the bulkheads of the body. These two short longerons have, in plan, a direction parallel to the line of flight, while the main longerons continue on their converging course. This arrangement is indicated in the plan view, Fig 11. In side elevation, the short longerons, against which lie the inner ribs of the tail plane, have the same curvature as the tail plane. In this manner the lines of the rear part of the body are not spoiled, while an easy-flowing curve is provided for running the tail plane into the body.

Fig. 12. One of the Turn-Buttons Securing the Engine Cowl to Upper Longerons

*(To be continued)*

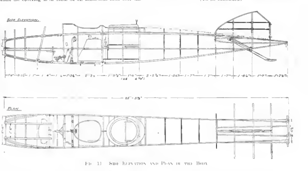



Fig 11 Side Elevation and Plan of the Body

## Aeronautical Patents

ISSUED FEB. 19, 1918.

1,256,670. To William R Fears, Camden N J Direct lifting hydroaeroplane
1,256,812. To Joseph Mader, Minneapolis Minn assignor of one-third to Merritt Brandon Minneapolis, Minn Airplane
1,256,823. To Cornelius H O'Rourke Hanford Cal Airplane
1,256,878. To Glenn H Curtiss, Hammondsport N Y, assignor to The Curtiss Motor Co Hydroaeroplane boat
1,257,040. To Petro Tatoryn Chester Pa Winged parachute
1,257,124. To Alfred L. Romero Oakland Cal Airplane
1,257,212. To Vincent P Gallo Fremensburg Pa Flying machine.

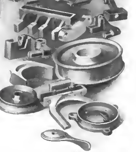
# The Application of Die-Castings in Aircraft

By Charles Pack

*Chief Chemist and Metallurgist, Doehler Die Casting Company*

Die-Castings may be defined as metal castings made by forcing molten metal under pressure into a metallic or permanent mould It can be seen from this definition that there are three vital factors essential to the success of a die-casting process, viz —

1 A metallic mould or die made of a material capable of withstanding the action of the molten metal and rapid temperature changes to which it is of necessity subjected during the casting operation



Aluminum Die Castings

2 A machine or appliance suitable for delivering the molten metal into the die or mould under pressure sufficient to insure a casting of perfect contour

3 An alloy suitable for the process.

Die castings being made in rigid moulds are cast close to given dimensions A certain slight variation must, however, be allowed for, which will vary with the nature and physical properties of the alloy employed For example, a tin-alloy die-casting can be produced and held within closer limitations than an aluminum alloy die-casting of similar shape and size. This, to a large extent, is due to the higher melting point and solidification shrinkage of the latter

From the foregoing it can be readily seen that the main function of a die-casting is to save on the machining cost of a given part Where this is not desired or is not of importance, the die-casting process is generally of little or no advantage

The dies or moulds used in the die casting process are machined from steel and to insure a die that will not crack or break up in service, the use of high grade special alloy steels are absolutely essential The making of these dies required skilled mechanics of the finest type The total cost of a die may vary from $150 for simple parts to $1200 for some of the larger and more complicated parts, some dies requiring three or four months continuous labor on the part of a highly skilled mechanic, for completion It follows from this, that the die-casting process is only applicable where large quantities of castings are required The minimum quantity depends largely upon the amount of machining that can be saved on the particular part in question The writer has found in his experience that few parts could be considered practical die-casting propositions in less than 1000 lots. Where 10,000 or more castings are required the die cost is readily absorbed and fades into insignificance.

With the foregoing in view, the possible applications of the die casting process to aircraft production can be more clearly understood Prior to the outbreak of the Great War, very few airplanes were produced in any considerable quantity in this country Die-casting being essentially a quantity production process, it is not surprising that the use of this process should have been very limited in the airplane industry, if indeed we had any such industry at that time The beginning of the present war also marks the advent of the commercial aluminum die-casting Prior to that time, all die castings produced were made from either zinc, tin or lead base alloys. Zinc alloys, although comparatively strong, are subject to corrosion under atmospheric conditions, and their use in airplane construction would be a serious mistake Tin alloys, although non-corrosive, have comparatively low tensile strength, and their use in airplanes were limited to motor bearings. This subject is discussed more fully later The high specific gravity and low tensile strength of lead alloys make their use in airplane construction almost prohibitive Thus we see at the present time with the airplane construction brought to a large quantity production and aluminum alloy die-casting developed to a high degree of efficiency, a new field of activity. There is absolutely no doubt that the die-casting will be as big a factor in aircraft production as it has been, and is at the present time, in the other automotive industries

Heretofore, the use of die-castings in airplanes was limited to motor bearings and accessories By accessories are meant magnetos, carburetors, speed indicators, weather gauges, starting equipment, etc, since all airplane manufacturers purchased these from standard producers of these articles. With the exception of the engine bearings, very few other parts in the airplane motor were die-cast since the quantities required were so small that it was found more economical to use other methods of production At the present time, however, dies for some 30 airplane parts are in the process of construction or have been completed and many more are under consideration

### Aero-engine Bearings

The bearings used in an aero engine must not be considered of secondary importance The type of bearing used, the design of the bearing and the bearing alloy are matters that are well worth careful consideration if an efficient engine is to be produced

The average engineer when thinking of bearing metal immediately says Babbitt Babbitt metal is named after the inventor Isaac Babbitt, and today covers a multitude of sins. Babbitt originally patented an alloy of copper, antimony and tin with the latter element in preponderance At the present time there are babbitt metals containing no antimony, some containing more or less lead and proportions are varied to suit the particular manipulator

Although, the hardness of babbitt metal can be varied to some extent, the fact remains that an increase in hardness is invariably accompanied by decrease in elongation or what is more commonly understood as brittleness A soft babbitt is more likely to "squeeze" or pound out under pressure, due to its low compressive strength, whereas a hard babbitt is likely to crack or crumble under a pound This is most particularly true of connecting rod bearings To overcome this difficulty the so-called babbitt lined bronze back bearing has been developed and is used almost entirely in aero-engine construction





The object of the bronze back bearing is to allow of the use of a thin liner of babbitt and combines the bearing qualities of a good babbitt metal with the compressive strength and rigidity of a good bronze The design of the bronze back bearing, and the method of making it are of vital importance The composition of the bronze, in the writer's opinion, is of minor importance, but the composition of the babbitt and the bearing alloy is very important

For the bronze back many alloys have been used, and some that have come to the writer's attention are given below —

| | Copper | Zinc | Tin | Lead | Phosphorus |
|---|---|---|---|---|---|
| 1 | [illegible] | | [illegible] | [illegible] | |
| 2 | 84 | [illegible] | [illegible] | 8 | |
| 3 | 80 | | 10 | | 1 |
| 4 | 80 | | 10 | 10 | |
| 5 | [illegible] | | [illegible] | 15 | |

Number 1 is the S. A. E. bronze specification The writer has had the best all round results with No 3 alloy, but as far as the actual efficiency of the bearing is concerned, either of the alloys given above will answer just as well

The method of joining the babbitt to the bronze shell is also important Engineers have long recognized the fact that the mere dove-tailing of the babbitt into the bronze by means of undercuts in the bronze was not a dependable means of holding the babbitt securely in place The modern bronze back bearing is held to the bronze by means of a perfect soldered joint over the entire bearing area Some engineers insist on having both the mechanical and soldered bond This in the writer's opinion is poor practice and only results in an extravagant waste of time, which at the present time should be avoided

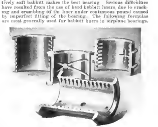
When the babbitt liner is properly soldered to the bronze shell, the babbitt is securely held at every point along the entire bearing area The babbitt will continue to be so held until the bearing reaches the temperature at which the solder melts. With the proper solder this temperature is 360 deg F, which is higher than the running temperature of any motor at this point Since the babbitt is held at every point by the solder, there is absolutely no strain put on the mechanical joint until the solder melts. If that condition should arise in an engine any mechanical lock formed by dove-tailing the babbitt would be practically useless, since the strength of the babbitt is very low, particularly at that temperature and the transverse strain applied to the mechanical bond (or babbitt bolt) caused by rotating of the shaft, would tend to shear the bond in short order

The foregoing is in strict accord with actual practice since bronze back bearings are now being used in a certain type of 210 hp aero-engines where the only bond used is a good solder joint In these engines there has been absolutely no trouble with the babbitt letting go Mechanical bonds here, as well as in automobile engines, proved an absolute failure

In joining the babbitt to the bronze it is important that the proper method be used The mere application of a soldering flux and solder to the bronze shell may result in the production of a bearing that, to all appearances, is perfect It will be found, however, that the strength of such a bond is exceedingly low The bronze shell should be carefully cleaned and surface scale removed The surface oxide should then be dissolved by the proper acids. The temperature and composition of solder bath should be guarded carefully

The writer has been asked on a number of occasions to advise on the means of determining whether a finished bearing has been soldered properly The writer frankly admits that the only proper and reliable test that he has been able to find is to break the bearing to pieces and see if it is possible to peel the babbitt from the bronze A test generally used is the "ringing" test A properly soldered bronze back bearing should, when held lightly in one hand and struck with a metallic rod, emit a clear ringing sound Unfortunately this test is not absolutely convincing since the rule does not work conversely A bearing that does not ring clear undoubtedly is not soldered properly, and should be condemned, but on the other hand when a bearing does ring, it does not prove conclusively that the solder joint is perfect since the bearing will ring true even if only the outer edges are soldered The only safeguard is to carefully guard the various operations and break up some of the bearings at frequent intervals.

The type of babbitt to be used deserves careful consideration There appears to be a difference of opinion amongst engineers as to the proper hardness of a babbitt liner The writer has found, by close observation, experiment and cooperation with army aviators, that a thin liner of comparatively soft babbitt makes the best bearing Serious difficulties have resulted from the use of hard babbitt liners, due to cracking and crumbling of the liner under continuous pound caused by imperfect fitting of the bearing The following formulas are most generally used for babbitt liners in airplane bearings,



Babbit Lined Bronze Bearings

and are given in order of the writer's preference based on actual results that have come to his attention

| | Tin | Copper | Antimony | Nickel |
|---|---|---|---|---|
| 1 | 91 | 4.5 | 4.5 | |
| 2 | [illegible] | [illegible] | 7.5 | |
| 3 | [illegible] | 3 | [illegible] | 1 |
| 4 | 84 | 7 | 9 | |
| 5 | 90 | 10 | | |

## Flax for Airplanes

The closing of the Russian ports and the growing demand for flax for aircraft fabric has prompted the British Government to create a Flax Production Department on the Board of Agriculture The intention is, says *Flight*, to make efforts to get 10,000 acres of the crop sown in the coming Spring so as to insure an adequate supply for the year and to provide seed for next year's requirements. Flax-growing was at one time extensively practiced in England, but with the general decay of agriculture which followed on the growth of industrialism, it became comparatively a defunct industry Yorkshire, Lincolnshire, Somerset and Fife were the chief centers, and it is in these counties that flax-growing is to be principally revived In the Yeovil district of Somerset and at Selby flax-growing is still practiced to some extent, and in these places the British Flax and Hemp Society and the University of Leeds have done much to encourage it

The terms that are being offered to farmers in suitable districts seem to be such as ought to induce them to carry out the board's desire without difficulty The Government is to pay £8 10s per ton for the total crop of seed and straw, and as a fair yield is from two to three tons per acre, and the seed for sowing is to be supplied free, there ought to be a very fair return to the farmer Moreover, the latter is offered an additional inducement in the shape of a guaranteed minimum payment of £14 per acre for all land suitably managed irrespective of the return of flax It has also been arranged that in case labor trouble should be a deterrent, the Flax Production Department will weed and harvest the flax at a level cost to the grower of £4 5s. per acre

## The Bristol-Curtiss Scout Has Trial Flight

The Bristol-Curtiss fighting scout biplane had a trial flight on March 13, at Curtiss Field, Buffalo, N Y According to press reports quantity production will be under way before the end of the present month

# Efficiency Variation in Airscrews

By M. A. S. Riach, A.F.Ae.S., Assoc.Inst.N.A.

Difficulty is sometimes experienced, in working out the curves of performance for airplanes, in arriving at a sufficiently correct estimate of the power available at various flight speeds.

This is mainly due to the difficulty in predicting *a priori* what changes in propulsive efficiency are to be expected over a fairly large range of flight speeds. Changes in engine revolutions, due to changes in translational velocity and density variation at various altitudes, which tend to further complicate the problem, present at the outset conditions which are difficult to calculate except in particular cases, and anyone who is seeking for formula to cover most cases met with in practice is likely to be discouraged by the seeming multiplicity

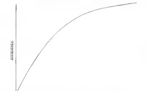



FIG 1

of variables entering into the problem and which possess no apparent easily definable connection with each other.

In dealing therefore with those cases most likely to be of use in practical work, mathematical exactness may have to be to some extent dispensed with, providing that expressions can be obtained which shall give results correct to a sufficient degree of approximation and at the same time be of a form sufficiently simple for ordinary use.

In the first place it is as well to notice at the outset that theories, however mathematically perfect they may be, can never be more than approximations to the facts if the assumptions upon which they have been built up are only near guesses at the truth, and it is indeed well to bear this in mind to avoid unnecessary labor in obtaining expressions which, analytically exact though they may be, still remain of the order of approximations only when their initial premises are themselves but approximations. There is unfortunately a certain type of person who is never able to appreciate the value of work of this kind and, in consequence, is very apt to deride what he describes as "theory" when any set of approximate solutions do not happen to agree with experiment.

These considerations, which apply to most branches of engineering science, are equally pertinent to the problems under discussion in this article.

There are two main variables which change the efficiency of an airscrew at different velocities of translation—namely, the slip or wake velocity and the drag/lift ratios of the blade sections.

The first is a necessary change considered from the point of view of the dynamics of fluid propulsion, whilst the second is incidental to the mechanism of propulsion employed.

Neglecting for a moment this secondary cause of loss in efficiency, we can, using R. E. Froude's expression for screw efficiency, write —

$$\eta = \frac{V}{V + \frac{S}{2}}$$

* "The Screw Propeller in Air," by M. A. S. Riach, read before the Aeronautical Society in March, 1917.



where $V$ represents the translational velocity through the fluid and $S$ the slip or wake velocity requisite to produce an axial thrust.

Since the above formula takes no account of the drag losses already mentioned, or of the race losses discussed in a previous article,† we infer that actual efficiencies met with in practice will be less than those which it gives.

This being so, let us write as a first trial:

$$\eta = \frac{kV}{V + \frac{S}{2}} \text{ where } K < 1$$

Then, in order to apply this expression we must know how $S$ changes with changes in $V$. This will be supplied by the following expression.

The useful work done per second axially is $MSV$, where $M$ = Mass/sec. of fluid through screw, so that the requisite B.H.P. to produce such work can be written

$$H = \frac{MSV}{550\,\eta} \text{ in lb. ft., sec., units}$$

$\eta$ being the propeller efficiency.

Now $M = \frac{\pi}{4} D^2 \rho \left(V + \frac{S}{2}\right)$, where $D$ = diameter of screw in feet,

and since $\quad \eta = \dfrac{kV}{V + \frac{S}{2}}$

we have $\quad S = \dfrac{2V(k - \eta)}{\eta}$

and $\quad V + \dfrac{S}{2} = \dfrac{kV}{\eta}$

so that $\quad H = \dfrac{\pi k D^2 \rho V^3 (k - \eta)}{1100\,\eta^2}$

or, $\quad \dfrac{1100\,H}{\pi \rho D^2 V^3 k} = \dfrac{(k - \eta)}{\eta^2}$

which gives in a simple and concise form an approximate formula connecting the air screw efficiency $\eta$ with the other quantities involved, namely, $H$, $\rho$, $D$, and $V$. The value of $k$ may be taken as varying between about 0.8 and 0.85. A value of $k = .82$ is probably a fair estimate to make. It is seen from the formula that $\eta$ is a maximum when it reaches

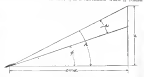



FIG 2

the value of $k$, and 82 per cent efficiency is probably a limit seldom attained in practice. A typical graph of $\eta$ against $V$, plotted from this expression, is given in Fig 1. This formula, while very simple and easy to apply, possesses one weak point. For values of the flight speed which are *less* than the speed for which the airscrew is designed, the results given by the formula are probably sufficiently accurate, but for values *considerably in excess* of the designed airscrew speed the efficiency of the airscrew falls very rapidly, although the formula given would make the efficiency progressively increase with increase of translational speed.

This defect in the formula is important when dealing with

† *Vide* "The Screw Propeller with Race Rotation," *Aeronautics*, September 19, 1917.
‡ *Vide* "The Screw Propeller in Air."



propellers which have been designed for very low flight speeds, as, for instance, in order to obtain improved climbing speed.

In order, then, to take account of this fall-off in propeller efficiency it is necessary to introduce into the formula an expression which shall more correctly measure the drag losses at translational speeds in the neighborhood of that at which there is no axial thrust. This is necessary for the reason that, apart from such losses, no power is required to turn the propeller when the axial thrust is zero.

Since the translational speed for zero thrust will not differ very greatly from the speed corresponding to the zero lift angles of the useful portion of the blade, we can roughly estimate the value of this speed which will then give us another point on our efficiency curve indicating about where the very rapid fall-off in efficiency is likely to occur in any case.

Let Fig 2 represent the case of the screw advancing at some translational speed $V$ and giving zero axial thrust.

The angle of attack —$\alpha$,* may then be regarded as being approximately equal to the angle of the lift of the section say $\beta$ so that we have —

$$\tan(\varphi - \beta) = \frac{V}{2\pi n \lambda}$$

where $\lambda$ may be regarded as being the "equivalent thrust radius" of the propeller and equal to $\lambda D$, say, where $\lambda$ is approximately the same for different propellers. If we take $\lambda = \frac{1}{\pi}$ we get —

$$\tan(\varphi - \beta) = \frac{V_o}{2nD}$$

from which we can at once find the value of $V_o$ for which the axial thrust is zero, $\varphi$ can be taken as the chord angle of the blade at a radius equal to $\lambda D$, or $\frac{D}{\pi}$ feet, say.

The determination of $V_o$ will then give another point on the curve of efficiency, and thus will to some extent indicate how the form of the curve changes at speeds greater than that for which the propeller is designed. The efficiency curve will then become modified as in Fig 3.

The work done (per second) against the frictional forces may be very roughly expressed as: $\mu\left(V + \frac{S}{2}\right)$, so that now the expression for efficiency becomes —

* *Vide* "The Screw Propeller in Air."

$$\eta = \frac{TV}{T\left(V + \frac{S}{2}\right) + \mu\left(V + \frac{S}{2}\right)} = \frac{1}{\left(1 + \frac{\mu}{T}\right) \cdot \left(\frac{V + \frac{S}{2}}{V}\right)} = \frac{1}{\left(1 + \frac{S}{2V}\right)\left(1 + \frac{\mu}{T}\right)}$$

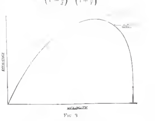



FIG 3

$$\eta = \frac{1}{\left(1 + \frac{S}{2V}\right) \cdot \left(1 + \frac{\mu}{MS}\right)}$$

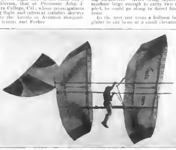
Whence it is seen that when $S = o$, $\eta = o$, since $M$ and $\eta$ may be considered as remaining constants. This shows, then, in a rough general way why the efficiency falls at zero slip due to the work required to be done in overcoming frictional losses.—*Aeronautics*

LIEUT. DEULLIN, A NEW FRENCH "ACE," ABOARD A POWERFUL SCOUT
(C) *Kadel and Herbert*

# An American Pioneer of Soaring Flight: John J. Montgomery

Among the pioneers of aeronautics who contributed their share to the realization of power flight there is one name which has nearly fallen into oblivion, that of Professor John J. Montgomery of Santa Clara College, Cal., whose investigations into the science of soaring flight and inherent stability deserve that his name be placed in the Annals of Aviation alongside with Lilienthal, Pilcher, Chanute and Ferber.

Attention has just been called to Montgomery's early work through an investigation made by Assistant Attorney General Huston Thompson and W. D. Eakin, who will defend the Government against the suit recently filed in the United States Court of Claims by the heirs of the late Montgomery.



The Montgomery Tandem Monoplane Glider

Montgomery's patent, applied for in 1905 and allowed in 1906, about the time when the most important of the Wright Brothers patents were granted, claims the use of an airplane wing curved from front to rear with means for changing its curvature, and also the parabolic form of curve. It is alleged that all airplanes now used by the Government infringe his patent.

The case will probably involve the question whether the use of the small, adjustable, supplementary planes at the ends of the wings known as ailerons is the equivalent of the warping of the wings employed by Montgomery. A similar question formed the main issue in the litigation of the Wright Brothers against Curtiss and others.

Montgomery's first small model soaring machines were tested by dropping them from a cable "stretched between two mountain tops." These were so well designed that in whatever position dropped—head first, tail first or upside down—they righted themselves and sailed off upon an almost level course. They also responded to changes in wind direction without losing stability.

Montgomery says in describing his experiments:

"Then I constructed a large machine patterned after the first model, and with the assistance of three cowboy friends personally made a number of flights in the steep mountains near San Juan. In making these flights I simply took the airplane and made a running jump."

That his assistants were cowboys may have some connection with the fact that the pilot sat on a saddle with his feet in stirrups by which the machine was controlled. Thus he literally "saddled the wind." Cords ran from the stirrups to the outer, rear corners of the wings and by bending them downward controlled the course of the machine.

On one occasion a pilot pressed too hard upon one of the stirrups and his winged steed rolled over in the air, "like one turn of a corkscrew," but contented itself with one roll and proceeded upon an even keel. This accidental but successful loop-the-loop was undoubtedly the first in the history of flight.

At the conclusion of one of his gliding flights down the mountain side Montgomery landed with one foot in a squirrel hole and so injured his leg that thereafter he was compelled to employ parachute jumpers to make descents from balloons. He states that he had sixteen applicants on his waiting list.

Professor Montgomery complains in his writings that his men were so eager to outdo each other in making spiral loops and figure eights that, "after these antics," he had to limit mechanically their control of the machine so as to permit only straight flights or long curves to prevent them from killing themselves. After being injured he planned to build a machine large enough to carry two men so that, though crippled, he could go along to direct his pilot and make observations.

In the first test from a balloon he wanted the pilot of the glider to cut loose at a small elevation as a test, but the pilot, probably with experience in parachutes that took time to open, made it understood that he was no small pond duck but a high diver and insisted on launching from a thousand feet or more. The landing spot was prescribed a mile away. Upon his cutting loose he lost his directions and started away from the spot but regained his bearings, brought his craft around and, passing through two or three clouds, proceeded to the landing place. After hovering over it, he settled gently to the ground. He had flown eight miles in twenty minutes.

These soaring tests were made with a 45 lb. glider about the time that the Wrights were experimenting at Kitty Hawk, N. C.

The accounts of Montgomery's first flights, describing considerable stretches of perfectly horizontal flight, intimate that his machine employed to some extent the "internal energy of the wind," which was the subject of much of Langley's research. Similarly, by taking advantage of certain changes in direction and velocity of the wind, as the soaring birds do, the energy of their bodies serving momentarily as a kite string. Orville Wright in 1911, long after the advent of the airplane, returned to Kitty Hawk, the scene of his early gliding and power flights down Kill Devil Hill, and there without an engine, rose on a fifty mile gale and stayed up for nearly ten minutes.

Montgomery's experiments with curved wings were much retarded by his failure to copy in all features the wings of the gull, after which his wings were patterned. At first he could see no reason for curving the forward edge downward. It has since become known that a curved wing exerts a lift even though it be tilted downward three or four degrees below the plane of the wind, making the angle of incidence negative. He finally suspected that nature was correct, however, in giving a sharp downward curve to the forward edge. He set a barn door in the position of an airplane wing in the wind and released thistle down in front of it. He found that the air changed its course before reaching the obstruction and struck it at an upward angle. Then he reproduced faithfully the wing of a soaring bird and constructed his most successful gliders.

Following the same pattern he later produced wings having approximately the same ratio of length to chord, that is, an aspect ratio of 1:1, in order to compromise between lifting power and structural strength. The longer and narrower the wing of a given area, that is, the higher its aspect ratio, the greater is its efficiency, but considerations of strength make it impracticable to extend them beyond certain limits. Therein lies the explanation of the use of biplanes and even triplanes in the great lifting machines. Montgomery's machine was a so-called tandem monoplane, the wings being placed behind, instead of below, one another.

The small relative efficiency of a wing of low aspect ratio accounts to some extent for the lack of success attained by the





airplane of Maxim, who spent a hundred thousand dollars upon it a few years before power flight was mastered by the Wrights.

Montgomery's point of power application was of course identical with his center of gravity, since gravity was his power. The only other force acting upon his machine was the air resistance. Thus the only line of stress was between the center of pressure and the center of gravity, and his machine had somewhat the inherent stability of a parachute.

Professor Montgomery's experiments began in the early eighties. Like many others he first tried machines with flapping wings. The results were of course unsuccessful, because of the great energy loss and jerking effect of reciprocating motion and the inconstant application of power. In the airplane, by contrast, the pressure of each part is constantly in the same approximate direction and the changes in degree of pressure are gradual. Momentum, both in the rotation of the propeller and in the forward motion of the machine, is cumulative and is conserved instead of being broken up and set against itself as must occur in any reciprocating device.

But if Montgomery's start was not based upon the most appropriate principle of physics, it was patterned after nature's example in the flapping birds. He merely copied the wrong bird. When he changed his model to the soaring species, nature's best energy conservers, he met with success.

It is interesting to note, in view of man's endeavors to provide the airplane with inherent stability, that the soaring bird has in the bone of his head a sort of compound spirit level made of three liquid filled tubes extending in the three dimensions, which is nature's device for automatic or reflex control.

While Montgomery's machine was only a glider, its action in the air serves as a good basis for consideration of the seeming miracle that a propeller exerting a backward pressure of only four or five hundred pounds may keep in the air a machine weighing a ton. The Wright Brothers based their calculations upon the action of similar wind coasters at Kitty Hawk. Assuming that the glide is of such efficiency as to coast down a ten to one slope at twenty miles per hour, it yields to gravity only at the rate of two miles per hour. An upward air current of only two miles per hour, a very gentle ascending breeze, would suffice to keep it up. The relatively small energy represented by this imaginary upward wind is approximately the amount of energy demanded of the engine. In this connection it is interesting to note that the Wright Brothers made many flights with an engine developing only 14 hp.

The glide is compelled by the inertia of the air over which it passes to follow a certain path more or less downwardly inclined, according to the glider's efficiency. It simply coasts down a hill of air. Now, to hold a load on a hillside we know that a horse need not exert as many pounds against the collar as the weight of the load, it only exerts a component of gravity's force, determined by the slope of the hill. So with an airplane, the engine for horizontal flight needs to exert only sufficient force to hold the machine on a hillside of air.

In 1905 one of Montgomery's jumpers, Maloney, was to give an exhibition for a military company, in which were many of his friends, to whom he had promised a sensational flight. In the rise from the ground one of the balloon's guy ropes whipped around the glider's framework and broke it. A warning was shouted to Maloney, but he either did not hear it, or else preferred to take the risk rather than disappoint his friends. He proceeded to a great height and cut loose. The glider turned over and settled to the ground like a parachute. Maloney's body was but slightly scratched, and it is thought that he died of heart failure on the way down.

Montgomery's own death occurred in 1911 in an attempt to launch the glider from greased skids, when a sudden gust of wind dashed him to the ground.

# On the Battle Front in France

A French Town Under Bombardment of German Batteries as Seen from Aloft
*Photo Western Newspaper Union*

# International Aircraft Standards

(Continued from previous issues)

### 3N17 Specifications for Aluminum Alloy Tubing

GENERAL.—1 The general specifications, 1G1 shall form, according to their applicability, a part of these specifications.

MATERIAL.—2 The specific gravity of the aluminum alloy of this specification shall not be greater than 2.85

MANUFACTURE.—3 No scrap shall be used in the manufacture of this tubing other than that produced in the manufacturer's own plants and which is of the same composition as the material specified

WORKMANSHIP AND FINISH.—4 The tubing shall be straight, clean, smooth and free from all injurious defects both inside and outside

PHYSICAL PROPERTIES.—5 *Tensile Test*—(a)

| | Minimum tensile strength Pounds per square inch | Kilograms per square millimeter | Minimum yield point Pounds per square inch | Kilograms per square millimeter | Elongation in 2 inches per cent |
|---|---|---|---|---|---|
| Temper 1 | 55,000 | 38.6 | 35,000 | 24.6 | [illegible] |
| Temper 2 | [illegible] | [illegible] | 25,000 | 17.6 | 20 |

*Bend Test*—(b) A section of the tubing of a length approximately equal to the outside diameter of the finished tube shall withstand being flattened into an oval of which the minor interior axis shall be not less than 4 for temper 2 and 8 times for temper 1 the thickness of the wall of the original tube

*Hydrostatic Pressure Test*—(c) Each tube shall be subjected to a hydrostatic pressure which will develop a tensile stress of 7,000 pounds per square inch (4.92 kg mm²) in the tube, but in no case shall a test pressure of more than 1,000 pounds per square inch (0.703 kg mm²) be required. Each tube must withstand this test without cracks, flaws, leaks or other defects, such as bulging.a

SELECTION OF TEST SPECIMENS.—6 Each bar shall be subjected to a hydrostatic test. A tensile and a bend test specimen shall be taken from each 100 feet of tubing or lot of less than 100 feet

DIMENSIONS AND TOLERANCES.—7 (a) The following tolerances shall be allowed on aluminum alloy tubing

*Outside diameter*—(b) For tubes less than 2 inches in outside diameter ±0.003 inch, for tubes from 2 to 3 inches in diameter ±0.005 inch

*Wall Thickness*—(c) The wall thickness of the tube shall be not less than the specified gauge and shall not be exceeded by more than 0.004 inch for tubes less than 0.008 inch in wall thickness nor by more than 5 per cent for thicker tubes

*Variation*—(d) The variation in thickness due to eccentricity of the bore must not exceed 10 per cent of the specified wall thickness.

*Length*—(e) When tubing is ordered in definite lengths, no length furnished shall be less than that specified

a The pressure to be applied shall be calculated from the formula

$$P = \frac{7\,000T}{R}$$

Where $P$ = the hydrostatic pressure in pounds per square inch
$T$ = the thickness of the tube wall in inches
$R$ = the internal radius of the tube

### 3N19—Specifications for Bronze Castings for Bearings

GENERAL.—1 The general specifications 1G1 shall form according to their applicability a part of these specifications

USE.—2. These castings shall be used for small unlined bearings and bushings.

MATERIAL.—3 The castings shall have the following chemical composition

| | Per cent |
|---|---|
| Tin | [illegible] |
| Zinc | [illegible] |
| Iron not more than | [illegible] |
| Lead not more than | [illegible] |
| Copper | Remainder |

MANUFACTURE.—4 (a) The bronze shall be made from lake or electrolytic copper conforming to I A S B specification 2N2 and pig tin having a purity of at least 99 per cent

(b) No scrap shall be used in the manufacture of these castings other than that produced in the manufacturer's own plants and which is of the same composition as the material specified

WORKMANSHIP AND FINISH.—5 Castings must be homogeneous and free from shrinkage cracks, spongy spots, blow holes, and foreign matter. Any castings developing defects in machining must be replaced by the manufacturer. The full weight of material in the original casting must be returned by the purchaser for each replacement.

PHYSICAL PROPERTIES AND TESTS.—6. Bronze castings for bearings shall have the following physical properties

| | Pounds per square inch | Kilograms per square millimeter |
|---|---|---|
| Minimum tensile strength | 35,000 | 24.6 |
| Minimum yield point | 19,000 | 13.3 |
| Minimum elongation in 2 inches | 9 per cent | |

SELECTION OF TEST SPECIMENS.—7 (a) The test bars shall be cast to size either from the casting if the size of the same will permit or from a separate block. The test bar shall be connected with the casting or block by a 0.125 inch (3.18 mm) gauge running the entire length of the test bar

(b) The test bar shall be of such a form that it can be machined to the I A S B standard test bar. Its total length shall be not less than 6 inches (152 mm). The diameter of the reduced section shall be approximately 0.57 inch over a length of 2.25 inches.

(c) At least two test bars shall be cast from each heat. Test bars and castings shall have the heat number cast or stamped upon them

(d) One test shall be made to represent each heat but in case of a flaw in the test bar or a break outside of the middle third of the gauge length further tests may be made on extra test pieces as provided for in the foregoing paragraph

DIMENSIONS AND TOLERANCES.—8 All castings must be true to pattern, cores must be correctly placed. Surfaces which are to be machined shall admit of finishing to the required dimensions without leaving any trace of the original surface

### 3N22—Specifications for Free Cutting or Screw Machine Brass Bars

GENERAL.—1 The general specifications 1G1 shall form according to their applicability a part of these specifications

USE.—2 This material is to be used for screw machine work. It is not suitable for structural parts of airplanes and is intended only for use in machine parts not subject to considerable stress.

MATERIAL.—3. The bars shall have the following chemical composition

| | Per cent |
|---|---|
| Copper | 60.0 to 63.0 |
| Lead | 2.25 to 3.0 |
| Iron not more than | .10 |
| Other impurities not more than | .35 |
| Zinc | Remainder |

MANUFACTURE.—4 The brass shall be made from lake or electrolytic copper conforming to I. A S B specification 2N2 and spelter of "C" or "D" grade conforming to I A S B specification 2N3. No scrap shall be used in the manufacture of these bars other than that produced in the manufacturer's own plant and which is of the same composition as the material specified

WORKMANSHIP AND FINISH.—5 All bars shall be sound, straight, free from cracks, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish

PHYSICAL PROPERTIES AND TESTS.—6 The bars shall have the following physical properties

*Tensile Test*—(a)

| | Minimum tensile strength Pounds per square inch | Kilograms per square millimeter |
|---|---|---|
| Bars less than 1 inch in diameter | 55,000 | 38.6 |
| Bars from 1 to 2 inches in diameter | 50,000 | 35.1 |
| Bars over 2 inches in diameter | 45,000 | 31.6 |

*Bend Test*—(b) The bars shall withstand being bent cold through an angle of 120 degrees to a radius equal to the diameter of the rod without cracking. The bend test bar shall be full size up to a diameter of 1.50 inches. Test bars of rods of larger diameter may be machined to a diameter of not less than 1 inch

SELECTION OF TEST SPECIMENS.—7 The bars shall be grouped into lots of not more than 500 pounds if of one-half inch or less in diameter, or into lots of 50 pieces if larger. A tensile-test specimen and a bend test specimen shall be cut from one bar of each lot.

DIMENSIONS AND TOLERANCES.—8. Bars shall not vary in diameter more than the following amounts

| | Inch |
|---|---|
| For bars up to and including 0.375 inch in diameter | ± [illegible] |
| For bars from 0.375 inch up to and including 1 inch in diameter | ± [illegible] |
| For bars over 1 inch in diameter | ± [illegible] |

DELIVERY, PACKING AND SHIPPING.—9. (a) Bars when ordered to any length shall be furnished in stock lengths unless specifically required that lengths be exact

(b) Stock lengths will be as follows

When ordered in 12-foot lengths no length shall be less than 8 feet.
When ordered in 10-foot lengths no length shall be less than 8 feet.
When ordered in 8-foot lengths no length shall be less than 6 feet.
When ordered in 6-foot lengths no length shall be less than 4 feet.

(c) When ordered to the lengths given above the weight of lengths less than length ordered shall not exceed 40 per cent of any one shipment.



# Digest of the Foreign Aeronautical Press

### The Aeroplane (London), February 20, 1918

*Commercial Aviation Possibilities in China*—By Allen J. Daniels—China to a great number of people conveys the idea of a large cultivated country, peopled by millions of half-savages. As a matter of fact, the country in reality is as different as possibly can be from such a state. The land is cultivated on every inch of fertile soil, the people are solid, industrious and far ahead of a great number of so-called civilized countries.

One of the greatest drawbacks to China's progress at the present time is the lack of means of communication. By far the greater portion of China's internal commercial traffic is carried on by water. Railways are only in their infancy, they are slow and very unreliable. On the so-called long distance journeys there is usually only one train up and down per day, and it takes one, on an average, three times as long to accomplish a distance as it would on a European line.

It is really only quite recently that a postal system has been inaugurated, but the people have been very quick in learning its uses, and have taken up its advantages with enthusiasm, as will be seen from the fact that the receipts for the last financial year exceeded the expenditure by nearly two million dollars. The Chinese have taken very kindly to the "Express" post, and a great amount of mail is carried "Express" now, and the volume is increasing daily.

It is safe to say that the Chinese would welcome any means that would accelerate the mails to the utmost. Of course, as the railways increase in number and efficiency, the mails will be greatly accelerated, but should a system of mail-carrying by air be introduced, it would take but a very little time to make it a good paying enterprise.

For the purpose of mail-carrying, the waterplane would be a far more useful machine than the land plane, at least for the next few years, as there are very few places of importance that are not close to some waterway. And it is safe to say that a good-sized waterplane would find little difficulty in rising from or landing on any of the rivers of this country.

With regard to the fuel supplies, this would present no difficulties whatever, as there are already two large oil companies in China with a network of agencies and sub agencies over most of the country. These companies are spreading rapidly, and in a very short while, will embrace the whole of China.

The Chinese themselves could easily be trained as mechanics, and if necessary as pilots. They have proved themselves to be very apt motor-car drivers with little or no nerve. There are hundreds of motors and steamboats in China run by Chinese engineers entirely, and I feel confident that with special training the Chinese would become expert airplane mechanics.

China is taking an interest in aviation from a military point of view, and there are one or two machines and pilots capable of flying, as will be seen from the fact that the Military Governor of the Province of Hunan, who is at the time of writing trying to quell a rebellion in his Province, has asked the Central Government to help him by sending a couple of airplanes.

### Aeronautics (London), Feb. 27, 1918

*The Air Force Estimates*—On Feb. 21, for the first time in English history, the House of Commons considered the Air Force Estimates, which were introduced by Major Baird, Under-Secretary of State to the Air Ministry. Major Baird outlined the composition of the Air Council and the respective functions of its members as follows

The chief of the Air Staff is charged with advising His Majesty's Government as to the conduct of air operations in all questions of air policy affecting the security of the Empire, including home defence. He is further charged with liaison with the Allies, with the Admiralty, and with the Army Council as regards policy, operations, and intelligence. Under his department falls the subject of policy as to air organizations and establishments. The principles of training are laid down by him. Schemes of development of the air force are also settled by him. Guidance as to the specifications of aircraft, engines, armament, ammunition, and other equipment, strategic and tactical dispositions of air stations, and general schemes for works and aerodromes—that covers, briefly, the sphere assigned to the Chief of the Air Staff.

The Master General of Personnel corresponds generally to the Adjutant General on the Army Council. He is charged with the duties of raising the personnel of the air force, with its maintenance, both in officers and men, with the selection of candidates for commissions and with the posting of officers and men to the units to which they belong.

Discipline and all legal questions connected therewith fall within his sphere, as well as the arrangements for the medical and sanitary services.

The Controller-General of Equipment combines the functions of the Master General of the Ordnance and the Quartermaster-General on the Army Council. He is charged with the supervision of the provision of aircraft, engines, armament, ammunition, and other equipment in accordance with the schemes and guidance as to the specifications of the department of the Chief of the Air Staff, and the arrangements with the Director General of Aircraft Production for the production of these stores, and for experiment and research to improve the designs and supply of all such equipment.

The Director of Lands is charged with taking over, whether by agreement or under the Defence of the Realm powers, all land required by the Ministry, and the management and maintenance from an estate point of view, and subject to the requirements of the air service, of all lands taken over, exclusive of any constructional work. All constructional work falls within the province of the Administrator of Works and Buildings. I may say that we have taken over *en bloc* the works and lands held by the Army Council and the Admiralty respectively in connection with the Royal Flying Corps and the Royal Naval Air Service.

The duties of the Parliamentary Under-Secretary of the State combine, *mutatis mutandis*, the functions of the Parliamentary Under-Secretary of State for War and the Financial Secretary to the War Office.

The duties of the Secretary to the Air Council comprise the general control and cooperation of Air Ministry procedure and of the conduct of official business in the Air Ministry.

### Aeronautics (London), March 6, 1918

*Standardization of Aero-Engines*—An interesting sidelight was shed on the British aero-engine situation in a speech made by Mr. Pemberton Billings on Feb. 27 in the House of Commons. Mr. Billings said: At the present time we are carrying spare parts to the extent in London alone, I think, of something like £15,000,000 value for airplane engines. I have heard of a sum almost equalling that I do not say being wasted but lying dormant in other parts of the country, so that spare parts may be ready for all these engines to which I propose to refer.

I may say that our enemies, the Germans, have succeeded in reducing their standard engines to approximately 7 per cent. They employ 160-hp 6-cylinder Mercedès and 260-hp 6-cylinder and 240-hp 8-cylinder Mercédès, 130-hp 6-cylinder and 240-hp Benz; 250-hp 8-cylinder Maybach; 100-120-hp 9-cylinder rotary Monosoupapa Oberursel, and 160-hp Austro Daimler. With one or two exceptions, this is practically the whole output of enemy airplane engines. Seeing that our enemy has efficient engines, seeing that we who have access both to the assistance of America, Italy, and France, three of the greatest engineering countries in the world—America for production and France and Italy for high efficiency—we yet find ourselves at the end of three and a half years of war without one engine that we can really rely on.

Despite the protestations of certain honorable members, or the protestations of the representatives of the Air Ministry in this House, that I am utterly wrong as to the forty-four types which were standardized, or forty-four engines which were carrying spare parts, I find on referring to my old service notes and to information at my disposal today that at least sixty-one engines have been standardized, and that is anything but a complete list. I find that 90-hp, 110-hp and 130-hp Clerget, 100-hp and 120-hp Monosoupape-Gnôme, and 80-hp, 110-hp and 130-hp Le Rhône, three distinct types of engines, have been in the recent past standardized engines of both the Royal Flying Corps and the Royal Naval Air Service, the spare parts blocking up the stores of the Royal Flying Corps and the Royal Naval Air Service. If

an engineer were asked to give a report he would tell you that there is nothing between the Clerget and the Le Rhône, either the 80-hp. or the 110-hp or the 130-hp So far as the Naval Air Service is concerned, they have got the 100 hp Monosoupape-Gnôme There is the 80-hp. ordinary Gnôme I do not know whether it is established or whether it has been wiped out

There is the 250-hp. Sunbeam 12-cylinder, and the 360-hp Sunbeam 18-cylinder, and the 275 hp 12-cylinder and 8-cylinder Here we have four different types of engines and four different complete sets of spare parts to be attached to every squadron We come to the Eagle Rolls Mark III 12-cylinder, and the Falcon Rolls 12-cylinder and the 175 hp 6-cylinder, and we come to the Green 80-hp, 160-hp, and 360 hp, all involving sets of complete spare parts We come to the Renault Mercédès the Lorraine-Dietrich, and the Beardmore-Daimler 120 hp and 160 hp, and the Smith 140 hp. We come to the Curtiss, and this country, I may almost say, is littered with Curtisses

Now is the time for the Air Minister to adopt a firm attitude on this question He should say that out of these sixty-three types of engines there should be one on which we can rely for training one or two for fighters, and two, three or four for bombers, and that we will put our faith in those, and he should cancel all the contracts of all those people, who are simply wasting priceless materials and workmanship making engines that will never be employed He should also cancel the vast orders for spare parts and concentrate on about six types of engines and devote all our energies to making those engines as perfect as possible We come to the Hispano-Suiza 150-hp, 150 hp geared, 200 hp, 200 hp geared, 200 hp *Poussé*, 200 hp *Surcompressé*, Peugeot, Bramer, Wolseley We come then to the Wolseley Adder and Viper, two more types, and we have the Arrol Johnston 120 hp and 150-hp and the Galloway 160-hp—another lot of engines with none of them interchangeable in any way We come to what has been the cause of half the tragedy of our experiments, the R A F 90-hp. 8-cylinder, 100 hp 8-cylinder, 130-hp 12-cylinder We have the Renault 70-hp and 80 hp

Then there is the A R 1, a very excellent engine, I believe, the result of designs in the Admiralty There is then the B R 2 and the A B C 45-hp 2-cylinder and 160-hp 7-cylinder, and the Fiat engine standardized by the authorities, and the Salmson 90 hp, 160 hp, and 200 hp The honorable gentleman (the Under-Secretary for Air) laughs at that, but I ask him at what date these engines were finally deleted from stock, and whether any firms, and how recently, have been engaged in making spare parts He might also inform us of what he knows of the latest type of this kind, and whether it is not the finest engine which the Allies have at their disposal today We also have the Anzani 60 hp and 100 hp and the Sturtevant 120 hp

*Flying* (London), March 6, 1918

*The New German Giant Airplanes*.—Allied aeronautical circles have for some time been aware of the existence of a new German "giant" airplane, veiled references to which have recently appeared in the German press

It appears that most of these machines are very big biplanes equipped with four engines The engines are placed between the wings much in the way that the engines of the Gotha biplanes are placed, but tandem fashion, so that one engine on each side drives a pusher air screw behind the wings as in the Gotha and the other engine on each side is placed immediately in front of it and drives a tractor air screw

Less is known, at any rate outside the Intelligence Department, concerning the six-engined *Riesenflugzeug* but it is assumed that it is probably a large triplane similar to the Caproni, probably with two bodies with a central body between them, in which case the central body would probably carry an engine at each end one driving a tractor screw and one a pusher—the other engines being disposed in pairs on the wings outside the twin fuselages. There are however several other ways in which these engines could be placed on a giant airplane, and as the six engined type must be at present purely experimental even in Germany, it seems improbable that any particular engine arrangements have yet been standardized

The chief reason for the existence of these giant machines is that they may carry enormous bombs which, according to German estimates, are to abolish whole sections of a city in one swoop That is to say instead of carrying two or three bombs of 200 lb apiece they will probably carry two or three bombs of 1000 lb apiece or possibly one enormous bomb of even greater weight

# The American Aircraft Situation

American production of combat planes has been slow in gaining momentum, but during July we will be able to keep pace with the Army's actual participation in the fighting In the meantime machines will go forward in gradually increasing numbers Deliveries of single seater fighters, pursuit and artillery control machines, orders for which were placed abroad, are now beginning to be made to General Pershing The production of training planes is keeping pace with the present requirements. Within thirty days production will reach a point which will necessitate the storing of some of these machines as a reserve. These are the salient facts vouched for by one of the highest officials of the Air Service during an interview given a representative of AVIATION AND AERONAUTICAL ENGINEERING on March 25

At a joint meeting on March 30, the War Council and the Senate Committee on Military Affairs discussed at length the military situation on the western front in France, and all phases of ordnance progress and preparation and the aircraft situation

The exact condition in regard to the aviation program and the present state of progress was disclosed The information laid before the Senate Committee confirms the outline of the situation given above It was definitely shown that there is no ground whatever for statements which have been made by persons summoned before the Senate Committee that not more than thirty-seven all-American fighting machines will be delivered to General Pershing by July 1. On the contrary, unless the bottom drops out of the entire organization, and the great plants which are turning out motors and beginning to turn out planes other than those of the training type, which already are being delivered in large quantities, and have been for many weeks past, General Pershing will have by midsummer all the American planes he can use on the front

A report said to have been made to the President by Gutzon Borglum on the aircraft situation was printed in part in the New York *World* of March 22 It must be remembered that these statements apply to the situation as it was supposed to exist early in January Investigation indicates that the printed report is full of inaccuracies and exaggerations, that it is highly overwrought The truth lies between exaggerations on both sides of the question It will be found nearer the side of optimism than of pessimism The heads of the Air Service, it is said, will welcome publication of the facts developed by the investigation being made by Snowden Marshall E R Wells and Gavin McNab at the instance of the President.

The program is far from having collapsed It is agreed that the public has been misled as to probable accomplishment by ill informed publicity, a great deal of which, it should be noted, emanated from official sources It is also officially admitted that mistakes of omission and commission have been made, as well as miscalculation of the difficulties to be overcome

The original General Staff program upon which the $640,000,000 appropriation of last July was based did call for 22,000 Army machines of all types during 1918 But the incorrect impression seems to have gotten out that these were all to be "fighting" planes Another inaccuracy pointed out is that the *revised* schedule is said to call for 11,000 combat planes by the end of November As a matter of fact, the *original* schedule called for that number of machines of all types by the time mentioned Revised estimate of February provides for from 2100 to 2200 combat planes by July



One of the Borglum statements is that contracts for 7500 training planes have been let, and that after seven months we have 1444 on hand, of which 40 per cent are either worn out or useless The official tables now show more than two and a half times this number. He also asserts that production of training machines does not exceed 11 per day The official tables show a production of about 50 per day

More than 200 Liberty engines will be ready for foreign shipment by the end of April, and more than 2000 by the end of July, according to revised schedules. By the end of November 11,000 are expected to be on hand When maximum capacity is reached, a daily production of 150 engines is expected This statement is, of course, indefinite, but it is based on far better information than was available when the first contracts were let for a practically untried engine.

Comment on the conditions which are said to exist in the airplane factories would serve no good purpose at this time. Conditions are under investigation by an unprejudiced commission of practical men, and the facts will doubtless be made public at the proper time As to the countless changes in design which are complained of in the Borglum report and in the Providence *Journal's* investigation, the facts are about correct, but the conclusions drawn from them are not Nor have the changes originated within the organizations of the aircraft manufacturers. They have been dictated by the constant evolution of machines at the front, and by changes in detail to adopt parts and fittings to quantity production and a desire for the utmost perfection and efficiency. The result of this policy, over-standardization and reliance on machine production, is exactly what aircraft engineers predicted at the start

It should be recorded here that the personalities directed against Colonel Deeds and General Squier by Mr Borglum are considered ridiculous, and are given no credence by the Secretary of War, or by any others who know these officers.

The statement has recently been made that America has never intended and does not now plan to build single seater fighters because of constant changes in type and our great distance from the front In fact, the trend has drifted away from the single seaters to the more powerful squadron fighters. The work of constructing the small fighters and pursuit machines has, therefore, been left to France and England, upon General Pershing's recommendation How this statement is to be reconciled with the published fact that large orders were in January placed with Curtiss for the Bristol single-seater fighter is one of many mysterious conflicts in information Reports lately indicate that the single-seater will continue to play an increasingly important part in the air fighting

Various rumors have been current as to the performance of the American built De Haviland machine fitted with the Liberty engine These were to the effect that the speed of this machine was as low as 90 and as high as 138 m p h The representative of AVIATION was shown the tabulated performance records of all types of foreign machines, and can state that the speed the American De Haviland is officially credited with exceeds anything shown on the foreign performance tables If these machines approximate the speed indicated under average battle conditions they will do as well as their English prototypes

Offsetting certain charges made by Mr Borglum, responsible officials reiterate that the Liberty engine is a success, that there has been no profiteering that if the prices were high they were based upon speed of production, "the essence of the program" that there was no deliberate retardation, that there were many mechanical difficulties which had to be overcome, due largely to lack of experience and the fact that they were creating an entirely new industry, that there was an over estimate of productive capacity, but that the revised schedule is still highly satisfactory from a military standpoint, that the supply and industrial conditions affected the air program as it affected every other element of our war preparation

One point upon which all concerned on the governmental side insist is that the merit of the Liberty engine is certain and unqualified The geared 12 cylinder model now beginning to approach quality production will develop 460 hp on a weight of about 828 lb, that is, a horsepower for less than 2 lb weight

The advanced training planes tell a different story In this class mechanical difficulties were encountered that it has taken time to overcome, but there is reason to believe that the troubles have been corrected and that the output will be speeded up

The recommendation by Mr Borglum that the Government seize the chief airplane factories on the ground that $100,000,000 would be saved, morale improved, labor conditions protected, production increased 200 per cent, and the whole aeronautic department reconstructed, is unsupported by facts or figures As a matter of fact, the Government is now in virtual control of the airplane factories through its production officers, inspectors and accountants at the plants and through credits extended by the War Credits Board.

The criticism that only a comparatively small and favored part of the country's manufacturing resources have been utilized is a familiar one Two months ago Colonel Deeds testified before the Senate Military Affairs Committee that 65 firms and 400 sub-constractors were at work on the aircraft program. It is understood that this number has since increased It is a fact that there has been a great deal of bitter criticism by disappointed contractors who had neither the resources nor capabilities to manufacture airplanes or parts. On the other side there have been cases of what appears to be injustice to a few of the smaller airplane concerns which might have been practically subsidized and told to go ahead and produce something. If only one successful fighting machine had resulted from a dozen failures, the justification would be sufficient

The Borglum report includes an argument for the creation of a separate department of aeronautics to be distinct from both the Army and the Navy Commenting on this in its news story on the Borglum report, the New York *World* says: "In this respect Mr Borglum coincides with certain suggestions that have been made from time to time by the Aero Club of America"

The official publicity on the airplane program has in the past dealt entirely in generalities The official statements have always been qualified by large "ifs." Promises for the future have been made instead of telling the public the present situation The "ifs" are forgotten now The public was led to expect wonderful performances The inevitable reaction has come There have been many failures and disappointments, nevertheless, genuine progress has been made But the policy of concealment for the facts, and overwrought publicity for the promises, has resulted in one of the biggest "failures" in the present situation It is now less a matter of violation of military secrecy than of maintaining public confidence

It is understood that the Aircraft Board is now preparing an accurate statement of the situation which will help to restore confidence. This is needed.

## New Endurance Record

A Model 5A 8 cylinder, 150 hp engine, manufactured by the B F Sturtevant Co of Hyde Park, Boston, Mass, in the L-W-F Engineering Co training biplane No 83, established a new American endurance record, with a passenger, on March 28, at Ellington Field, Houston, Texas. The machine remained in the air continuously for a total flight of nine hours and fifty-three minutes The pilot was J H Yelle of the B F Sturtevant Co The machine left the ground at 8 25 a. m and landed at 6-18 p m The greater part of the flight was over the town of La Porte The engine, according to reports, did not miss an explosion during the entire flight, and the machine was only forced to descend after every drop of gasoline had been consumed The flight was made with 93 gal of gasoline and 11 gal of oil It ended with no gasoline and 5½ gal of oil The condition of the engine after the flight indicated that it could have remained up for several hours longer if sufficient gasoline could have been carried

## Recruiting of Non-Fliers Stopped

The work of recruiting for the non-flying units of the Aviation Section of the Signal Corps has been stopped temporarily Orders to that effect have been dispatched from Washington to all recruiting boards throughout the country

It is stated the reason is that sufficient recruits have been obtained for all these units so far organized and no more applications will be received until additional units are required. This will not be until from one or two months It has been understood for some time that the number of applicants has been large and that it is now very easy to obtain men for this branch of the service.

# News of the Fortnight

## The Latest Aerial Mail Plans

G. L. Conner, representing the Post Office Department in the matter of securing suitable sites for landing places for airplanes on the Washington New York aerial mail route, has returned to Washington, D. C., after having spent four days on this mission in New York and suburbs. To a representative of AVIATION AND AERONAUTICAL ENGINEERING, Mr. Conner stated that in the party were also Postmaster Walter C. Burton of Brooklyn, two members of the Brooklyn Chamber of Commerce, and Major Holden and Captain Solomon of the Signal Corps.

In addition to the sites mentioned previously as having been investigated were sites in Belmont Park, Jamaica and other places on Long Island. The one which is considered most available now is a tract of Flatbush Gardens on Kings Highway, about twenty minutes haul by motor from the Brooklyn post office. It seems to be the present purpose to take this site, if a lease can be secured, but if not, one of two other sites which have already been looked over, may be acquired. It is thought a definite decision may be made this week.

If the site on Kings Highway is secured, the plan is to speed the mail by automobile to the Brooklyn post office, whence it will be shot by pneumatic tubes to the several post offices in New York City, but should the contracts for the pneumatic service not be renewed, and this question is now before Congress, it is admitted that this part of the plan will be somewhat disrupted.

The Department is now working toward the development of devices, which will permit the starting and landing of airplanes from and on a very much smaller field than is now required, or even from or on the roof of a post office or other large building. Very satisfactory progress in this direction is reported to have been made and should these devices prove to be successful, two results would accrue, the necessity of the pneumatic tubes, motor trucks and landing fields in connection with the aerial mail service would seem to be obviated and the delivery of mail matter would be materially expedited.

It is pointed out that a landing field of the size now required, or about 2000 sq. ft., is one of the difficulties which stands in the way of the general employment of airplanes for postal and commercial purposes. It is also stated that the difficulty of securing proper sites at New York and Philadelphia will delay the opening of the route a month or more beyond the date last set. The original date was April 15, which was changed to April 25, but it is now thought that the opening of the service will be postponed to as late as May 15. It is intended, however, to inaugurate it as much earlier than the last named date as possible.

League Island, which was regarded as good as settled as the Philadelphia landing field, has necessarily been eliminated from further consideration on account of the work which is being done there for the Parking Commission and which will not be completed for about one year. The Philadelphia situation, therefore, must be reinvestigated and a committee of Department and Signal Corps officials is planned at this writing to go there for that purpose.

The extension of the aerial mail route to Atlanta, Ga., which was reported in the AVIATION AND AERONAUTICAL ENGINEERING as having been proposed to the Department by Congressman Thomas M. Bell of Georgia, is out of the question at the present time. Mr. Bell was so informed in a letter from Postmaster General Burleson on March 14. The Postmaster General wrote that there is no immediate prospect of an extension as the funds available will not permit it.

## Flies from Mineola to Washington

Lieut. Georges Flachaire of the French Army's aviation corps, flew from Mineola, N. Y., to Washington, D. C., last week. Lieut. Flachaire made the 250 mile trip in a Spad fighting scout.

He started from Hazelhurst Field soon after the noon hour, but encountering engine trouble passed the night at Philadelphia, resuming the journey at 10 o'clock the following day. He reached the infantry parade grounds at Camp Meade at 11.15, descended and took lunch there and resuming his trip at 2 p. m., and was in Washington fifteen minutes later.

Lieut. Flachaire has seen two and one-half years' service at the front and has downed seven enemy planes.

## $188,042,969 for Naval Aeronautics

Chairman Lemuel P. Padgett of the Committee on Naval Affairs, reported to the House of Representatives on March 19 the annual naval appropriation bill (H. R. 10854) for the fiscal year ending June 30, 1919.

The text of the paragraph making an appropriation for aircraft reads:

"For aviation, to be expended under the direction of the Secretary of the Navy for procuring, producing, constructing, operating, preserving, storing, and handling aircraft, establishment and maintenance of aircraft stations, including the acquisition of land by purchase, donation, or condemnation, and for experimental work in development of aviation for naval purposes, $188,042,969: Provided, That the sum to be paid out of this appropriation under the direction of the Secretary of the Navy for drafting, clerical, inspection, and messenger service for aircraft stations shall not exceed $300 000."

This sum is an increase from approximately $94,000,000, the amount originally asked for by the Department.

By the bill the enlisted personnel of the Naval Reserve Flying Corps is increased to 10,000. Included other legislation recommended is the transfer of all members of the National Naval Volunteers for aeronautical duties to the Naval Reserve Flying Corps, and that no officer of the N. R. F. C. shall exercise command except within his particular department or service.

It is also provided "that hereafter the allowances of officers, enlisted men, and student fliers of the naval service shall in no case be increased by reason of the performance of aviation duty."

A report of the committee accompanying the bill explains that "this provision does not take away the increased pay of aviators, but does take away increased allowances."

This is understood to have been a last minute change made in the bill at the request of Secretary Daniels, who after learning the decision reached by the Senate Committee on Military Affairs at the recent hearing on the pay of Army aviators, wrote the chairman of the House Committee on Naval Affairs, placing his department in line with the amended War Department bill.

## Liberty Engined Seaplanes Fly

Naval seaplanes fitted with Liberty engines have recently made a number of trial flights.

The following statement regarding these tests has been issued by the Navy Department:

"A Navy flying boat, equipped with a Liberty engine, flew from the Naval Air Station, Hampton Roads, Va., to Washington yesterday (Wednesday, March 20) morning in two hours. The distance covered was about 180 miles. The motor and plane functioned as expected and the aviators report that the engine ran without a miss. Three naval aviators made the trip in the plane—Lieut. D. H. McCulloch, Ensign Slater, and Ensign G. M. Brush.

"Seaplane hangars have been erected on the Eastern Branch of the Potomac at Anacostia and similar flights will be made.

"The Navy has several service seaplanes equipped with the Liberty engine which are flying daily."

A second test on March 22 was made with two seaplanes, one of which was equipped with a Liberty engine and the other not. It was in the nature of a comparative test, with the Liberty plane winning the honors. It is stated that the Liberty outdistanced the other plane in the competition.

This test was witnessed by Secretary Daniels, Rear Admiral David W. Taylor, Chief Constructor and Chief of the Bureau of Construction and Repair, Rear Admiral Robert S. Griffin, Engineer in Chief and Chief of the Bureau of Steam Engineering, and Rear Admiral Ralph Earle, Chief of the Bureau of Ordnance.

## Test of Briggs Seaplane

The Briggs Aeroplane Co., which is located in the building of the so-called Portland Brewery on Washington Street, Alexandria, Va., completed its first machine last week. This is a seaplane and is now stored in the company's hangar at Jones Point, that town. Trial flights will be made shortly. They will be in charge of Leonard Bonney.



# Congress Has Before It These Appropriations for Aeronautics

| | |
|---|---|
| To continue Army program for balance of fiscal year ending June 30, 1918 | $250,000,000 |
| New Army appropriation for fiscal year beginning July 1, 1918 | 1,126,654,260 |
| Naval appropriation for fiscal year beginning July 1, 1918 | 188,000,000 |
| Post Office Service | 100,000 |
| National Advisory Committee for Aeronautics | 260,000 |
| Total | $1,565,014,260 |

The aircraft program is behind schedule. Present facilities must be speeded up. At the same time, increased sources of supply must be developed. Additional airplanes and engines are under consideration, are in process of design, and in some cases the first experimental planes and engines have been built. Production must be gotten for these new types in plants which have not yet been utilized.

Active steps are being taken by the Government, through the Post Office Department, and other departmental agencies, by Chambers of Commerce throughout the country, by corporations and individual groups looking toward the commercial era of aeronautics. The actual opening of this era will take place this spring, when the airplane postal route between New York and Washington will be inaugurated.

With new appropriations of $1,565,014,260 for Army and Naval aeronautics becoming available, the next six months will see an expansion which was not even contemplated when the unprecedented sum of $640,000,000 was appropriated last August.

Our Service Department is well equipped to give any information wanted. Your inquiries will receive prompt attention. Write to

**Aviation and Aeronautical Engineering**
**120 West 32d Street — NEW YORK CITY**



# Gillette Safety Razor

***Have You Seen the New Gillettes Specially Designed for the Fighting Man?***

THESE models were designed by members of the Gillette Organization who have seen service with the Colors and know what the soldier is up against.

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The Gillette is the one razor for the man who is doing things—the one razor with world-wide use and reputation.

When a man wants new Blades he can get them at any Post Exchange or Y. M C A. Hut—here in America or Overseas.

Our Paris Office carries stocks—is constantly supplying the American Expeditionary Forces. Gillette Safety Razors and Blades on sale everywhere in France, England, Italy and the Eastern battle fronts.

## *The Minute a Man Puts on a Uniform*

The fighting man doesn't want to dawdle around. He wants to do a thing right—and get it over with.

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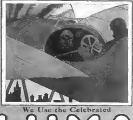

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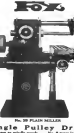

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*Names of Advertisers in this issue are printed in capitals*
*See Index to Advertisers on page 332*

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Lawson Aircraft Corp
Lewis & Vought Corp
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Longren Aeroplane Co
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(Continued on page 321)


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Complete guide on ALL paper work of all branches of the Service

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*Complete catalogue on request*




*(Continued from page 319)*

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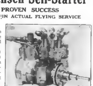

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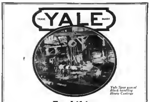


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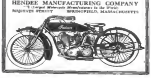




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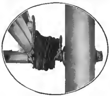

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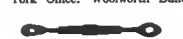

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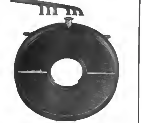

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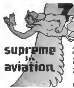

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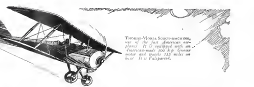

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Our Service Engineering Department makes a specialty of solving difficult bearing problems If you have any such problems our Engineers will be glad to give you the benefit of their wide experience.

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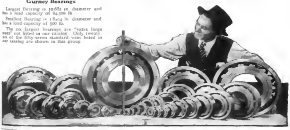

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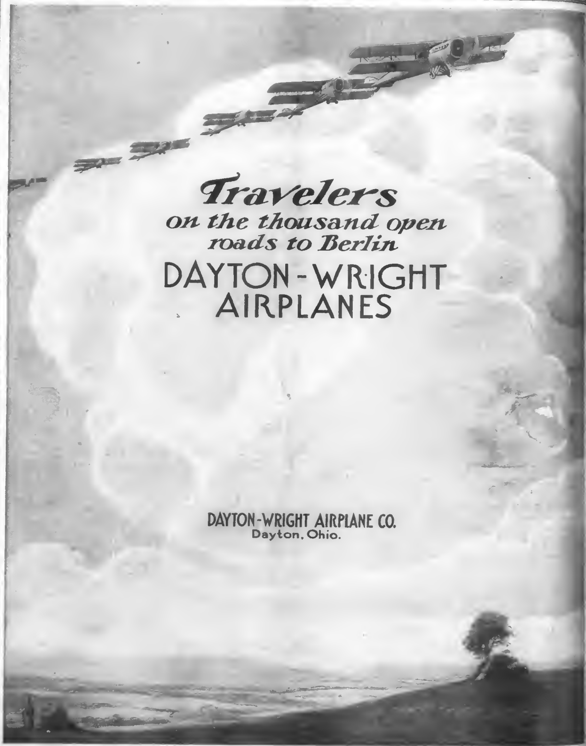
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